DOCUMENT RESUME

ED 276 233 EC 191 351

AUTHOR	Murphy, Harry, J., Ed.; Dunnigan, J. A., Ed.
TITLE	Computer Technology and Persons with Disabilities: Proceedings of the Conference (Northridge, California, October 17-19, 1985).
INSTITUTION	California State Univ., Northridge. Office of Disabled Student Services.
PUB DATE	86
NOTE	335p.; For selected individual papers, see EC 191 352-361.
AVAILABLE FROM	California State University, Northridge, Office of Disabled Student Services, 18111 Nordhoff St., Northridge, CA 91330 ($12.95; California residents enclose $13.79).
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01/PC14 Plus Postage.
DESCRIPTORS	Braille; *Communication Aids (for Disabled); Communication Disorders; *Computer Assisted Instruction; *Computer Software; *Disabilities; Educational Technology; Electromechanical Aids; Elementary Secondary Education; Hearing Impairments; *Microcomputers; Multiple Disabilities; Physical Disabilities; Severe Disabilities; Speech; Visual Impairments

ABSTRACT

Twenty-seven papers are presented from a conference on applications of computer technology for disabled persons. The following titles and authors are represented: "Computer Applications For Rehabilitation Organizations: Finding What You Need" (T. Backer); "Similarities In Cognitive Development Of Severely Physically Handicapped and Younger Regular Students" (S. Ball); "Telecommunications For The Physically Handicapped" (P. Cunningham and J. Gose); "Very Low Cost Applications Of Talking Bar Code Technology Combined With Pictorial And Alphabetic Language Symbols" (J. Curran); "Strategies To Promote Integration and Acceptance Of Students With Disabilities Among Their Non-Disabled Peers, Using Microcomputers" (D. Dutton); "Speech Synthesis As A Teaching Tool" (F. Fisher); "The Use Of Microcomputers In Program Evaluation" (C. Fitzpatrick); "Dexter: A 'Talking' Hand For The Deaf-Blind" (D. Gilden); "No Monitor or Keyboard Needed for Computerized Educational Devices For Blind Children" (D. Gilden); "Interactive-Observation In Communicative Disorders" (E. Hall et al.); "Teaming The Classroom Computer With A Textbook For Teaching Phonics To Hearing-Impaired Students" (S. Hart-Davis); "Alternative Access Methods For Users Of Computer-Based Information Systems" (D. Jaffe); "Integrating Computer Technology With Severely Handicapped And Learning Handicapped Students" (R. Kleitman et al.); "Miss STIM: An Extra-Interactive Electronic Learning System" (C. Knoppel et al.); "A Keyboard Emulator For The IBM PC" (R. Lodewyck); "RADIO ACTIVE: A Microcomputer-Based Radio Access System for the Severely Physically Handicapped" (R. Lodewyck); "Creative Uses Of Synthetic Speech For The Hearing Impaired" (S. Longacre); "High Tech For Multihandicapped Individuals" (S. Longacre); "APL: A Language To Assist Disabled People" (D. McIntyre and R. McIntyre); "Computerized Symbol Processing For Handicapped Persons" (R. Osguthorpe et al.); "Making Apple Computers

Accessible To Blind Children" (A. Renouf and S. Phillips); "Computer-Assisted Fitting Of An Implanted Cochlear Prosthesis" (J. Sinclair et al.); "Computer Technology For Communicatively Handicapped Pupils In Public Schools" (D. Soroky et al.); "Visagraph Eye-Movement Recording System" (B. Talluto); "The PortaBraille--A Communication Device For The Blind" (W. Thompson); "Computer Applications In Deaf Education" (R. Trachtenberg); "The Integration Of Logic Software Into The Curriculum Through Activities Away From The Computer" (L. Ware). (CL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED276233

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

PROCEEDINGS
of the Conference

"Computer Technology and Persons With Disabilities"

California State University, Northridge
October 17-19, 1985

1958

Harry J. Murphy
J. A. Dunnigan
Editors

EC191351

BEST COPY AVAILABLE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Harry J Murphy
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

To order additional copies of this Proceedings, please enclose $12.95 (California residents enclose $13.79) and send to:

Office of Disabled Student Services
California State University, Northridge
18111 Nordhoff Street
Northridge, CA 91330

Copyright 1986
California State University, Northridge
Office of Disabled Student Services

TABLE OF CONTENTS

Computer Applications For Rehabilitation Organizations: Finding What You Need.............. 1
Thomas Backer

Similarities In Cognitive Development Of Severely Physically Handicapped And Younger Regular Students.............. 11
Stanley Ball

Telecommunications For The Physically Handicapped.............. 19
Pat Cunningham and Joan Gose

Very Low Cost Applications Of Talking Bar Code Technology Combined With Pictorial And Alphabetic Language Symbols.............. 35
John Curran

Strategies To Promote Integration And Acceptance Of Students With Disabilities Among Their Non-Disabled Peers, Using Microcomputers.............. 45
Donna H. Dutton

Speech Synthesis As A Teaching Tool.............. 54
Farah Fisher

The Use Of Microcomputers In Program Evaluation.............. 61
Colleen Fitzpatrick

Dexter: A "Talking" Hand For The Deaf-Blind.............. 66
Deborah Gilden

No Monitor Or Keyboard Needed For Computerized Educational Devices For Blind Children.............. 73
Deborah Gilden

Interactive-Observation In Communicative Disorders.............. 76
Ed Hall, Ruth Harris and Julianna Secor

Teaming The Classroom Computer With A Textbook For Teaching Phonics To Hearing-Impaired Students.............. 91
Sandra Hart-Davis

4

Alternate Access Methods For Users Of Computer-Based Information Systems.............................. 121
David L. Jaffe

Integrating Computer Technology With Severely Handicapped And Learning Handicapped Students.................................... 130
Richard Kleitman, George Haskell and Toby Dowling

Miss STIM: An Extra-Interactive Electronic Learning System...................................... 142
Curt Knoppel, Betty Fried and James H. Bargelt

A Keyboard Emulator For The IBM PC............................. 156
Ronald W. Lodewyck

RADIO ACTIVE: A Microcomputer-Based Radio Access System For The Severely Physically Handicapped...................................... 175
Ronald W. Lodewyck

Creative Uses Of Synthetic Speech For The Hearing Impaired...................................... 192
Steven T. Longacre

High Tech For Multihandicapped Individuals...................... 200
Steven T. Longacre

APL: A Language To Assist Disabled People........................ 208
Donald McIntyre and R. Ewen McIntyre

Computerized Symbol Processing For Handicapped Persons...................................... 224
Russell T. Osguthorpe, Linda Li Chang and Scott B. Mitchell

Making Apple Computers Accessible To Blind Children....................................... 249
Andrew Renouf and Susan Phillips

Computer-Assisted Fitting Of An Implanted Cochlear Prosthesis................................. 259
J. Stephen Sinclair, Rosalyn Firemark and Jerome I. Dickman

Computer Technology For Communicatively Handicapped Pupils In Pubic Schools............................. 288
Doris Soroky, Joe Abel, Kathy Boyle, Sally Cook, Nancy Kahn and Peggy Morrison

Visagraph Eye-Movement Recording System......................... 292
Bonnie Talluto

The PortaBraille - A Communication Device
For The Blind.. 307
Wayne Thompson

Computer Applications In Deaf Education.............................. 312
Renee Trachtenberg

The Integration Of Logic Software Into
The Curriculum Through Activities Away
From The Computer.. 325
Linda Ware

Computer Applications For Rehabilitation Organizations: Finding What You Need

Thomas Backer
Human Interaction Research Institute
Los Angeles, California

Modern computer technology offers many exciting opportunities for rehabilitation organizations of all sorts -- from state vocational rehabilitation agencies to private for-profit counseling firms to rehabilitation hospitals. Computer systems can aid in recordkeeping, financial management, and administration. The computer also can help assess client characteristics and match disabled clients with appropriate jobs or training opportunities. In short, the computer revolution is here for rehabilitation, just as it is for the rest of society.

But many rehab organizations are now struggling with the problem of how to identify, acquire and install the best computer systems to meet their particular needs. Initial enthusiams for "going computer" often leads to systems being purchased without well-defined objectives, and without adequate information about what alternatives are available. This situation often is aggravated by aggressive salespeople who "push" their hardware or software, plus problems in getting the financial resources needed for full implementation. Finally, many administrators discover to their chagrin that installing a computer system isn't just a matter of buying it and sending out a memo telling staff they'll now be using this wonderful new technology. As with any major organizational change, lack of a careful, psychologically-sensitive implementation plan can lead to significant staff resistance and many practical operating problems.

To counter these difficulties and increase the chances that computer technology will work effectively in rehabilitation organizations, the Regional Rehabilitation Network (RRN) has developed a five-step information/technical assistance consultation process. This process is offered through a "brokerage service," which networks together an organization wishing to install a computer system, or upgrade existing computer technology that helps with administrative or client assessment functions, with other individuals and organizations. RRN may bring an organization together with:

- *technical assistance consultants expert in various aspects of computer technology
- *vendors of hardware or software systems
- *consultants with special expertise in the psychological aspects of system implementation, such as overcoming staff resistance or providing effective staff training
- *other rehabilitation organizations that already have had success with similar computer systems
- *organizations that can provide funding, or consultation on resource acquisition

The networking/brokerage process enables an organization to be linked with as many different information resources or consultants as required for its particular needs.

About RRN

The Regional Rehabilitation Network (RRN) is funded by a five-year cooperative agreement between the National Institute of Handicapped Research and the Human Interaction Research Institute. RRN serves rehabilitation professionals throughout Region IX (California, Arizona, Nevada, Hawaii and the Pacific Territories), helping to promote the wider use of innovative programs and practices in rehabilitation. RRN provides a number of services based on principles of social networking -- one of the key strategies for making society run more smoothly, according to such authors as John Naisbitt in Megatrends and Alvin Toffler in The Third Wave (Backer, in press).

RRN gathers information about innovations in two subject areas:

*SCHOOL-TO-WORK TRANSITION PROGRAMS
*COMPUTER APPLICATIONS IN REHABILITATION

Innovative programs from within the Region and nationally are identified, and RRN then conducts a careful validation study to determine whether the new program is ready for wider use. Innovations reviewed favorably by the RRN Advisory Panel are made available to interested practitioners and rehab organizations in Region IX via regular newsletters called UPDATES, other print publications, conferences, telecommunications, and other means.

Those interested in RRN's innovations then can request RRN's brokerage service (described above), bringing together the organization wishing to adopt or adapt a new program with information services or consultants. RRN can even support limited travel and other expenses involved in getting consultants and a potential adopter together.

The Five-Step Process

There are five steps in RRN's information/technical assistance brokerage process for rehab organizations wishing to install or upgrade a computer system for administrative or client assessment functions:

1. SETTING OBJECTIVES
   *What do you want to accomplish with the computer system?

*Why is the computer the best choice for this purpose?

*"Is this trip necessary?" (a slogan from World War II gas rationing, meaning here -- could the purpose be served just as well without computerization?)

The specific computer applications RRN can assist with are the following (from a model presented in Backer, 1985):

Case Management

--Intake and initial eligibility review
--Time in status report
--Caseload analysis
--Computerized client "paperwork" (e.g., IWRP)

Administration

--Management information systems
--Computerized billing
--Management reporting
--Program evaluation

Client Assessment

--Psychological characteristics
--Vocational interests
--Vocational abilities/experience
--Disabilities/handicaps
--Job readiness behaviors

Job Matching

--Analysis of worker traits
--Specific labor market search
--General DOT search
--Training program match

Report Writing

--Specialized word processing for evaluation reports, counselor reports
--Computer assistance in making recommendations (Baker, 1985)

2. INFORMATION GATHERING

*Help in identifying alternative choices of both software and hardware (the main emphasis of RRN is on software -- hardware choices include major manufacturers such as IBM, DEC -- see Appendices A & B for software choices)

*Help in identifying scientific/professional information resources (see Appendices C & D; also see Burkhead & Sampson, 1985, Golter, 1985; Golter & Golter, in press; Growick, 1983; McCray & Blakemore, 1984; McMahon, Burkhead & Sampson, 1985; Schmitt & Growick, 1985)

3. PLANNING

*Help in setting up a computer planning committee -- to include representatives of staff at all levels of the organization

*Sessions with top executives on key goals of the planned computer system-- to ensure support from the top

*Development of written plan for implementing stated objectives

4. RESOURCE ACQUISITION

*Identification of vendors to provide "comparison shopping" presentations (with researched list of questions for each presentation)

*Assistance in identifying financial resources -- e.g., a donation from a computer company, as with Apple's donation of hardware to human service agencies;

availability of "credit card" from companies such as IBM; help in arranging a special donor gift for purchase of the computer system (using as an analogy the endowing of a building or wing)

*Identification of overall technical assistance consultation if needed (there are consultants who specialize in working with human service organizations that are computerizing)

5. IMPLEMENTATION

*Helping to deal with organizational resistance

*Identifying resources for follow-on consulting (e.g., customizing software)

Some Examples

RRN currently is working with both Goodwill Industries of Los Angeles and the Exceptional Children's Foundation in L.A., both of which are installing computerized management information systems. These facilities already have bought minicomputers, a considerable financial investment which now will be matched with an investment in software for accounting, development, record-keeping, and a number of other purposes. RRN has been gathering information about the very best and most promising computer software in these areas, and also about what local consultants are most expert in issues such as software selection and customization, or helping to overcome staff resistance to use of the computer.

RRN is also providing brokerage services for several private, for-profit rehab counseling firms in Southern and Northern California;

for the rehabilitation department of a large hospital, which has just started a vocational assessment unit; and for a Project with Industry program in Los Angeles wishing to implement a computer-based system originated in Arizona.

Networking for Self-Help

In addition to what RRN can provide, agencies also can network on their own to acquire more resources for computerization. For example, a local group of facilities or private sector firms could band together to hold monthly sharing meetings or to proceed through implementation of a given system "as a group" (e.g., all buy the same microcomputer and case management software to meet similar needs). In some cases one organization might set up a system and offer it to other local organizations on a "service bureau" basis, as Goodwill Industries of Milwaukee has done.

For those individuals or agencies embarking on their own networking activities, RRN has identified some basic rules for the networking process:

#1. Keep a focus. There is a reason for your network; don't lose sight of it. New interests and more complex relationships may emerge through networking, but as the principal intent of its formation becomes less clear, the greater the chance the network will cease to meet its members' needs.

#2. Stay in touch. A network is not a network without communication. With the focus in mind, make it a point of "touching base" every few weeks or months with other members.

#3. Keep it small. If you follow Rule 2, you'll need Rule 3. We believe that even natural, active networkers are more successful within multiple, small, focused networks than within single giant ones. The networks may overlap, but each is bitesize and workable. When networks get too big or too formal they cease being real networks. They are then associations or families or brotherhoods or sisterhoods, but not networks.

#4. Keep it simple and cheap. Start-up need not require computer purchases. The strength, endurance, and effectiveness of the network is often directly related to its lack of complexity and the low cost of active participation.

#5. Reciprocate. We're in this together. I expect to count on you, just as you can count on me. Unlike marriage, we won't need a court order to end the network if there's not reciprocation, but the split will be no less evident. (Backer & Vash, 1984, pp.6-7).

Implementing a computer system in any rehabilitation organization is a complex, challenging task. The resources provided by good networking can help, both in solving problems and in providing some emotional support for the process of change that will be needed to make the new system work.

* * *

This paper was prepared under Grant #133LH50003 from the National Institute of Handicapped Research. Those interested in the

Regional Rehabilitation Network should contact: Regional Rehabilitation Network, Human Interaction Research Institute, 10889 Wilshire Boulevard, Suite 740, Los Angeles, California 90024 (213) 879-1373.

References

Backer, T.E. (1985). *Evaluation of RRN Action Conference on Computer Applications*. Los Angeles: Human Interaction Research Institute.

Backer, T.E. (in press). Networking in rehabilitation. *Journal of Rehabilitation*.

Backer, T.E., Vash, C.L. (1984). *Guide to networking in rehabilitation*. Los Angeles: Human Interaction Research Institute.

Burkhead, E.J., & Sampson, J.P. (1985). Computer-assisted assessment in support of the rehabilitation process. *Rehabilitation Counseling Bulletin*, *28*(4), 262-274.

Golter, G. (1985). Use of computer systems in private sector rehabilitation. In L.J. Taylor, M. Golter, G. Golter., & T.E. Backer (Eds.) *Handbook of private sector rehabilitation*, pp. 140-155. New York: Springer Publishing Co. Golter, G., & Golter, M. (in press). Rehabilitation and computerization. In Pan, E., Backer, T.E., Vash, C.L., & Newman, S. (Eds.) *Annual review of rehabilitation (Vol. V)*. New York: Springer Publishing Co. Growick, B. (1983). *Computers in vocational rehabilitation: Current trends and future applications*. Washington, DC: NARIC.

McCray, P.M., & Blakemore, T.F. (1984). *National directory of rehabilitation facilities using computers*. Menomonie, WI: University of Wisconsin-Stout.

McMahon, B.T., Burkhead, E.J., & Samson, J.P. (1985). *Computer access and applications to career counseling with vocational rehabilitation clients*. Washington, DC: NARIC

Schmitt, P., & Growick, B. (1985). Computer technology in rehabilitation counseling. *Rehabilitation Counseling Bulletin*, *28*(4), 233-241.

# # #

Similarities In Cognitive Development Of Severely Physically Handicapped And Younger Regular Students

Stanley Ball
The University of Texas at El Paso
El Paso, TX

Introduction

Recent research with the use of a carefully produced single-stroke Logo package by the author presented a cognitive hierarchy of development for students in grades K-3 (Ball, 1985). Because of potential differences in perception and psychomotor experiences which relate to directionality, length, and orientation, it is of interest to investigate the progress of physically handicapped students through these cognitive "benchmarks." This paper presents a brief description of and a rationale for the single-stroke Logo package developed for this investigation and some initial comparative results.

A Vehicle for Problem-Solving Development

Many potential uses of computers with the physically handicapped exist. The emphasis of this paper will be on logic/problem-solving development for students with communication problems which are due to physical impairment. The specific Logo package designed for this work unlocks an interactive world for these students which promotes cognitive decision-making.

Because of these students' difficulty with excessive keyboarding, it is desirable to use single-stroke activities with the computer. Also, Logo is used because of the graphic feedback provided the students. A sequence of shapes is presented (via the alphabet) which the students replicate using an increasingly sophisticated set of single-stroke Logo type commands. Selected shapes are shown in order of increasing difficulty in Figure 1. There are four levels and 104 shapes in all.

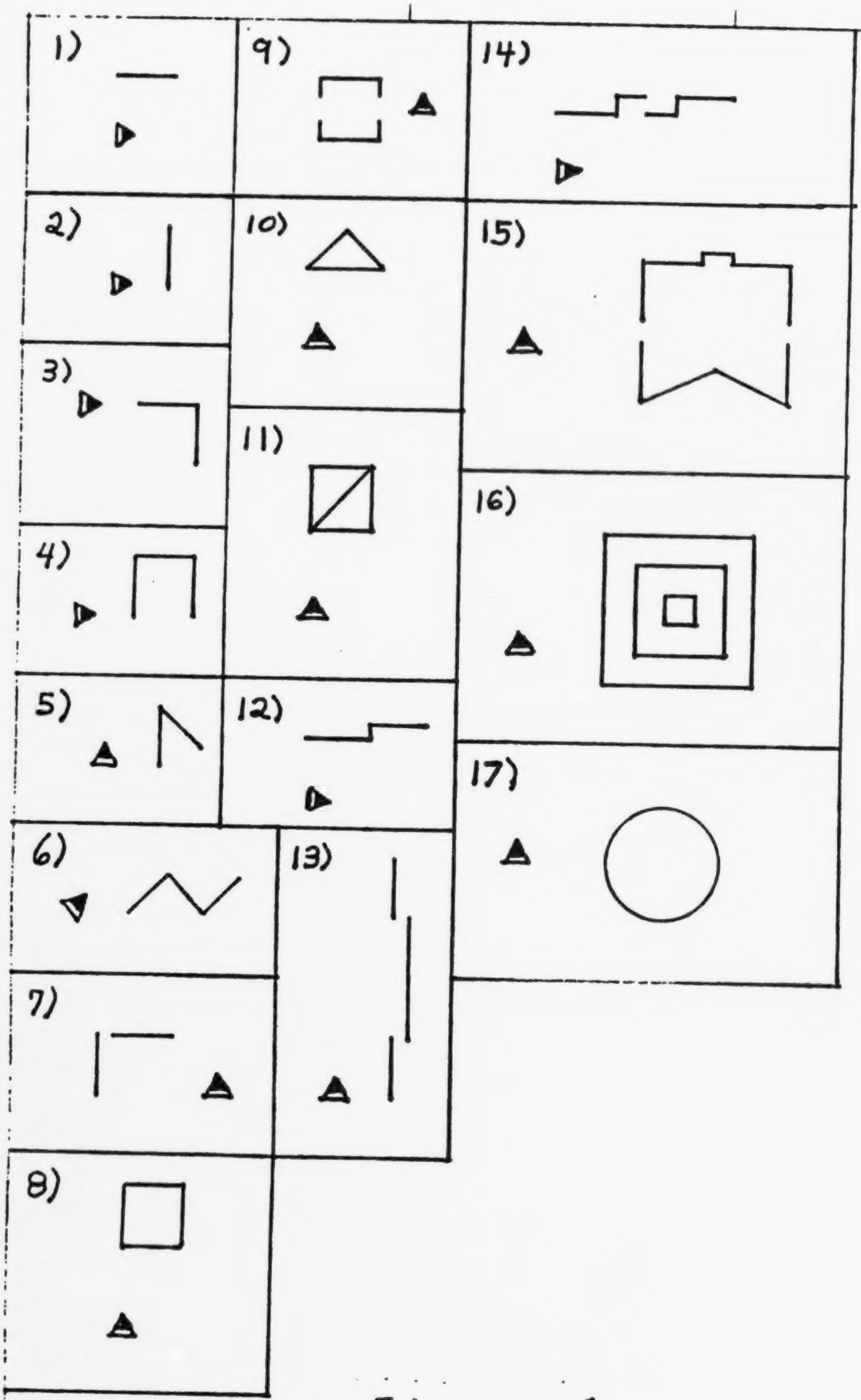


Figure 1

Students generally work alone at the computer with minimum supervision from a supervisor or teacher. The design for this sequence of problems (shapes) is to have students solve each one using strategies acquired by having succeeded with previous problems. The interactive nature of the computer provides reinforcement to the students so that they can "own" their solutions. Once the initial process of how the shapes are called and instructions are understood, students proceed through the shapes with little attention from any other person. No outside evaluation of students' work is necessary for the students to gain a sense of their success or failure. They are responsible for their own progress, as they develop decision-making strategies through experimentation.

Developmental Benchmarks

Previous research (Ball, 1985) has demonstrated a fairly consistent pattern of evolving sophistication on the part of young people as they proceed through the patterns. The nine benchmarks reported are:

1) students demonstrating simple control over the turtle rather than merely viewing the random motion of the turtle as they press keys,
2) students making primitive decisions about the direction the turtle is facing,
3) students making primitive decisions concerning the length of lines,
4) students utilizing the turtle's orientation as an aid to length correction
5) students demonstrating plan ahead strategies when they realize

an error,

6) students demonstrating length correction during subsequent trials,
7) students eclectically using the different turn keys,
8) students deciding which turn to use before either key is touched,
9) students paying explicit attention to the relative orientation of the shape.

Initial observations indicate that these sequential behaviors are fairly common to students in the early grades who have not had extensive previous experience with a computer.

Different Experiences for the Physically Handicapped

It is well known that physically handicapped (PH) people have not had the same benefits of psychomotor experiences which lead to perceptions and decision-making as others have. This would seem to be particularly true of the kinds of decisions necessary for the tasks presented here with Logo graphics. Length, direction, and orientation are all very much part of one's perspective and sense of self within the environment. Seymour Papert, in his important book, entitled Mindstorms, refers to "body syntonicity" as the relationship between Turtle geometry and students' knowledge of their bodies in space.

The trial-and-error learning accompanying crawling, walking, reaching, and turning all impinge on future interaction between individuals and their environment. The PH person is deprived of these experiences. Therefore, it becomes necessary to see if the PH student can interact with computer promoted graphic problems and can benefit from these interactions. How much does a student's moving in space have to do with their ability to progress through these patterns?

It is known that regular education students learn while they are away from the computer. On a given day, these students may not discriminate quite as well as one would like. However, without any external evaluation, these same students may return to the computer at a later date and demonstrate discrimination which is much keener as well as a desire for their task to be "more right." There is the question of whether students' movement about the world around them brings about this integration in a way which would not be possible for PH students.

Initial Observations

Within the obvious constraints of physically working slower, the PH students are able to provide the mental decision-making necessary to progress through the sequence of shapes much as regular education students do. Particular attention was paid to the evidence of discrimination of length and direction. PH students seem to relate the keystrokes and turtle action quite immediately. Exceptions to this general overall similarity between regular education students and the PH occur when the physical handicapping condition is accompanied by other brain related dysfunctions. This paper addresses only those PH students whose vision allows interaction with a monitor screen, whose emotional interaction is conducive to sitting at the computer without trauma, and whose communication skills are sufficiently well developed to understand the instructions.

There seem to be the same differences in personality evident. Some students will use the turn keys eclectically different from other students. Some students work more slowly, more exacting, or more in need of external reinforcement than others. There seems to be no evidence that PH students are responding to computer feedback any differently than regular education students.

Also, the PH students seem to progress through the same stages of experimentation with the length and direction. When today, the shapes did not quite match, tomorrow they will be the same. It is exciting to watch students make the decisions necessary to complete shapes they were unable to complete initially. Since these activities are presented without any evaluation on the part of any other person present, the students' success is totally dependent on their own strategy development.

Even though observation has been quite limited so far, there is reason to believe that PH students can benefit from activities such as these with single-stroke Logo. There have been instances of students with sufficiently severe physical handicaps to inhibit their getting feedback for their own decision-making in a timely fashion for correction with their other classroom materials. These students are deprived of a internally recognized sense of growth, until they have access to a computer. Then their delight is observable. Sometimes, this is the first time these students have had this successful experience.

What Kind of Learning is Taking Place?

Streibel (1983), in his discussion of the educational utility of computers, specifically asked about the learning potential of Logo. Many of these PH students can, in fact, constructively interact with the computer on tasks requiring length, direction, and orientation without having had the physical body-in-space experiences. Therefore, it seems that this computer interaction promotes a kind of cognitive development different from that resulting from a transfer of "body syntonicity."

There is increasing interest in the idea that interaction with a computer can, if the activities are carefully constructed, promote cognitive development which is not possible with any other media. This idea receives support from th work which is presented here. One possible explanation or description of what is taking place comes from Dickson (1985) who is studying the juxtaposition of symbol systems. This paper is not the place to pursue this concept with any depth. However, the question has some relevance to the kinds of tasks we present to PH students. They are in need of the ability to use efficient symbols to successfully interact and communicate with the world around them. Classroom computer activities such as reported here seem to have value in one form or symbol usage which is available to these students.

References

Ball, S. (1985). Programming benchmarks for the young student. School Science and Mathematics, 85, 374-382.

Dickson, W.P. (May 1985). Thought-provoking software: juxtaposing symbol systems. Educational Researcher, 30-38.

Papert, S. (1980). Mindstorms. New York: Basic Books, Inc.

Streibel, M. (1983). The educational utility of logo. School Science and Mathematics, 83, 474-484.

# # #

Telecommunication For The Physically Handicapped

Pat Cunningham and Joan Gose
Mesa Public Schools
Mesa, AZ

Telecommunication is one of the most popular computer applications. By connecting your computer to a modem (through a phone line) and then dialing, you can access commercial services or local boards. Appropriate communications software and hardware insures easy access to public and private boards and commercial services.

Telecommunications has expanded from basic information retrieval and electronic mail to a myriad of other services. Telnet, Compuserve, The Source, etc. offer many services beyond information retrieval and electronic mail. You can post a "letter" in seconds, look up a particular topic in an electronic encyclopedia, get the latest news on the wire services, look at stock prices or make airline reservations, or shop at home. Utilizing other services; you can bank, take college courses, or play an electronic game. With the capability for on-line conferences and "chats", lasting friendships can be made even though two people may never see each other. In short, telecommunications is an exciting computer development directly impacting disabled people who have very little opportunity to participate in activities that able-bodied people take for granted.

Non-verbal physically handicapped students can communicate via modem as well as you and I. Telecommunications and all its benefits are just as applicable to the physically handicapped user as to the able-bodied user. More importantly, telecommunications gives the physically handicapped user opportunities to interact with the environment that did not exist before. In spite of technical jargon, getting on-line is easy and enjoyable when you use software specifically made for this purpose. With a few modifications of equipment or addition of peripherals such as switches or electronic communication boards, physically handicapped persons can be just as adept at telecommunications as able-bodied persons.

What is needed to get started? Besides a computer, disk drive and printer, you will need a modem and some type of keyboard interface. The interface may be as simple as a mouth stick or as complex as an electronic language board.

A modem comparison chart will help you find the right modem for your system. Some of the terms used to describe features may read like Greek, but essentially what you are looking for is a direct connect modem; one end plugs into the computer, the other end into the phone or wall jack. Some computers will need an interface card, so be sure to check this requirement before purchasing a modem. Also, the phone line needs to be compatible with your modem, i.e., rotary or pulse tone. Consider your needs when purchasing a modem. A basic auto dial 300 baud (approximately 300 words per minute) will meet most needs. If money is no object, you may want a 1200 baud modem although the few advantages may not offset the extra expenses. Adaptive keyboard interfaces are an important consideration for physically handicapped students. Some students may be able to use the keyboard directly. For others a mouth or head stick, switch, or electronic language board like Express or Zygo may be needed. The best person to determine what interface should be used is your occupational therapist, or in some cases a medical equipment dealer. Costs of these accessories varies from a few dollars to several thousand dollars.

Once you have your modem, you need software which allows you to fully utilize the data base that will be accessed. Communications software allows you to automatically dial a service or bulletin board, download/upload programs, file programs, compose and send messages, print messages or files, and save messages or programs to disk. An important feature when choosing a software package is one key stroke commands to manipulate the data. This particular characteristic is important for physically handicapped students. I presently use "Data Capture." This software allows me to use one key commands from a menu to auto-dial, write, print, delete lines, save, or file data. Additionally, the software should have good documentation (easy to read manuals) and be relatively simple to understand. Your computer will somewhat limit your choices, but it's a good idea to take a look at two or three different software packages. Make a list of the features you want beforehand, then look at the software.

Prices on software varies from $50-$250 depending on the manufacturer and capabilities. Data Capture Apple IIe is relatively inexpensive ($49 and $89), but there is other software available at reasonable prices. It's best to buy software that suits your current needs. Once you are familiar with telecommunications software, you can always upgrade to a more extensive and high cost system.

Types of Computer Bulletin Boards

There are many types of computer bulletin boards waiting to be accessed by someone-you. Computer bulletin boards include those run by individuals, user groups, local boards, specialized professional boards and national boards like Tymnet, Compuserve, The Source, etc.

"The simplest and least expensive service available to you is one to one communication. You hook the computer to the phone line; call a friend then swap data and programs or type messages to each other using your keyboard.

"The next level of service is the bulletin board system (BBS). It's the electronic equivalent of those notice boards found in laundromats, libraries and other public places. A BBS is usually run by a computer user or user groups."[1] As you get more advanced, specialized and commercial boards are available. To find out what is available, the OMNI On line Data Base Directory and the Computer Phone Book together list more than 1400 national and local boards that are available.

The addresses and costs are listed below:

Omni On line Database Directory
Mae Millar Publishing Co.
866 Third Avenue
New York, NY 10022
ISBN: 0-02-079910-1 $10.95

The Computer Phone Book
New American Library, Inc.
1633 Broadway
New York, NY 10019
ISBN: 0-452-25446-9 $9.95 [1]

All bulletin boards systems are accessed through modems and greet you with some type of menu for making choices. Also, some bulletin boards require passwords to assure that only members gain access. All BBS's formats differ slightly from one another, but again, all usually have a "help" feature to bail you out if you get into trouble while trying to use the board. For example, when I log-on Telenet, the first thing my communications software does is give a menu with four choices. One choice is to run the Data Capture. I press #1 key and a new menu appears. From this menu, I select D for dial. Although my software has automatic dial, I prefer manual dial. When a connection is made, the menu disappears and Telnet greets me with a short commercial. It then asks me for my user name and password. In case you are slow, or have trouble, it gives you three tries to get either the user name or password right. If you don't after three tries it automatically disconnects you.

Once I am logged-on, the system tells me if I have mail in my "mailbox." I can read it and save it, or just read it without saving it to disk. If I just read it, it will be erased when I log off. After reading my mail, I can compose an answer. Once that housekeeping chore is done, I can roam through various bulletin boards looking for topics of interest.

Telenet will give you a list of bulletin boards, but once you know them, you can go directly to the boards you want. The whole process is very easy to learn and "help" is available. Another computer bulletin board, HEX (Handicapped Educational Exchange) is devoted to specifically to handicapped users. It provides information on different uses of technology and adaptations of technology to aid handicapped users.

Our high school students, do not access a commercial board. They call home, other computer users BBS's or user groups boards. On these boards they can "chat," upload and download programs, play games, etc.

Benefits of Telecommunications for the Physically Handicapped User:

The benefits of telecommunication to physically handicapped students are enormous. As stated previously, this is one and maybe the only sphere in their lives where they're on the equal basis with able-bodied persons.

At Mesa High, physically handicapped students using telecommunications are looked up to as "experts" by other able-bodied students. It has greatly enhanced their mainstreaming and social opportunities. Roles are reversed when the able-bodied student is dependent on the disabled student for assistance within this area. Some activities that able-bodied persons take for granted such as banking or shopping, are either very difficult or impossible for severely handicapped people to perform. With the advent of telecommunications, this has changed. These types of services are just becoming available and are rapidly increasing and expanding.

Present shopping facilities are available through Comp-U-Store, a 24-hour home shopping service which offers a variety of name brand products, usually at a good discount. Some of the products offered are appliances, electronic equipment, cameras, typewriters, household furnishings, sporting goods and much more. Shopping involves a few seconds to get "on-line." You can then look at what is available, make your selection, and purchase items all while on-line by charging the order to your charge card (orders can also be paid by check). Your purchase is then mailed to you. At present, the main drawback is that there is only a text description of an item. However, it is likely that in a few years, pictures will be added to the descriptions.

Banking at home is another feature of telecommunications. Provided you have a computer and modem (and in some cases bank supplied software), you can go on-line to pay bills, find out the status of your account, transfer money between accounts and inquire about your account. Although you cannot get cash from this system, one bank will mail travelers checks to you which you can then use much the same as cash. Security for banking by computer is extensive and valid as long as the user keeps password numbers, etc. safe.

Job Opportunities

It seems realistic to mention that computer-related job opportunities are one of the fast growing segments of the job market. Aside from programmers and service technicians; computer operators, system analysts, word processors, accountants, technical writers, information management specialists, etc. are just a few of the opportunities available. Because of telecommunications, many of these jobs will be able to be performed at a location other than the office; namely, home.

For these reasons, a computer-related job is a consideration for physically handicapped persons. It will be possible through telecommunications to make use of active minds often trapped within noncompliant bodies.

How to Access Other Systems

In the Mesa High School Physically Handicapped program we use an Apple 2 for word processing, basic academic skills reinforcement, programming, a communication device for non-oral students, recreation, and telecommunications.

We purchased the Apple 2+ because at the time it was the only computer which could interface with the adaptive devices required for our students. However, if students are able to directly access a keyboard then other models and/or brands may be used at considerable savings. Case in point: we located an "ancient" six year old Radio Shack Model One computer system which was donated to a student in our program. Though not state of the art, it is perfectly suited to this student. By typing with a mouth stick he can now complete assignments on a word processor program as well as access the PH program computer and others via modem.

Specialized requirements aside, these are the basic requirements for telecommunications:

Hardware:

1. computer, monitor, 1 disk drive
2. auto dial 300 baud modem (with dialing compatible with phone line-touch tone or rotary)
3. printer

Software:

Communications program: Slow response time is minimized by our communications program which uses abbreviated key strokes for dialing and logging-on. It also has a built in text editor which allows students to prepare messages of any length while off-line then send the entire file using a few key strokes. Case: A physically handicapped student prepares a letter off-line in 30 minutes and sends it to her mother's home computer in less than one minute.

> The contribution to a student's self concept cannot be overestimated. Telecommunications has allowed socially isolated individuals to meet people and make friends. Our students have become acquainted with a variety of computer

users across our metropolitan area. It also provides direct access to computer hobbyists who are resource people for our students and program.

How To Operate a BBS:

In addition to the items previously mentioned for telecommunications, BBS software is necessary. There are several commercial programs available: (the following are Apple/Franklin boards)

ABBS Version 4.0 $75
Software Sorcery
Software Sorcery
7927 Jones Beach, Suite 400
McLean, VA 22102

Access: $750.00

Computer Information Intelligence, Inc.
P.O. Box 31098   (more for business)
Phoenix, AZ 85046

GBBS II   * $95   Best
System version 1.7
Micro Data Products
5739 S. Olathe Court
Aurora, CO 80015
(303) 680-9292 modem   (303) 699-1161 Voice

NET-Works, $99.95
Nick Namio   Best
4877 Martin Road
Newburg, IN 47630

People's Message System/PMS $300.00
Bill Blue
P.O. Box 1318
Lakeside, CA 92040
619-561-7277

Beware of privately written "free" BBS programs. We have spent many frustrating hours attempting to operate a public domain program. Our program required extensive programming expertise and contained little documentation. We eventually abandoned it, in favor of a purchased user-friendly system; Net-Works. Local sysops were the best resource in selecting an appropriate program.

We have found the following features desirable in a BBS program: password capability, a user log with the capability of printing selected portions, uploading, downloading, multiple boards with security levels, time limit (this requires a clock card), single keystroke commands, electronic mail, and user friendly menus. We have found it is helpful to subscribe to several computer magazines. Most magazines feature a monthly telecommunications column as Link-Up magazine is a good sysop resource. Compute, A+, Family Computing, Softtalk, Popular Computing, and Byte are only a few of the many useful monthly magazines.

Problems and Solutions

The following problems/solutions have been experienced up to now in telecommunications and with our BBS.

Problem: Cost is approximately $2000 for computer and accessories. For example, Prenke Romich Express, through which some students access the keyboard costs $3000.

Solution: Equipment was purchased by district after a rationale was written. The school board and administration realize this equipment is necessary for students to receive an appropriate education. We have found the Adaptive Firmware Card to be a less expensive, easier to use scanner. Although not as versatile as the Express, it is better suited for computer interfacing since the scanning takes place directly on the screen rather than on an adjacent keyboard. At less than $500.00, this represents a considerable savings if interfacing with the computer is the only needed application. At the time we purchased the Express, telecommunications was a minor consideration.

Problem: We could not operate the modem. Hours were spent with high school computer teacher and student "whiz kids" trying to decipher manuals written by the technically minded. A service call to a technician revealed our modem is rotary dial while our school line is touch tone dial only.

Solution: Installation of a separate Mountain Bell phone line, cost six months and $$$.

Problem: Communications program supplied with modem doesn't allow data capture.

Solution: Purchase of a more sophisticated program. Cost: $125.00 and more delays.

Problem: System crashers and anonymous obscene messages.

Solution: October 1984, Link-Up "Crashproofing your BBS" by David Rolhman suggests:

1. set up log-on codes and passwords
2. limit the number of calls per day (clock card is needed) to three
3. make callers disclose names, addresses, and phone number
4. control secure software (all can be crashed)
5. use secure software (all can be crashed)
6. make electronic back-up daily
7. charge membership fees
8. check with local sysops for names of crashers
9. disk recovery programs

Problems: The electric wheelchair motors caused system crashes.

Solution: This was not a software problem but apparently static electricity. Spraying/wiping the area with fabric softener minimizes the problem.

Problem: Inexperienced staff.

Solution: We spent many extra hours with manuals, on phone, on other BBS's asking questions, working with students, reading magazines, talking to computer teachers in the school, and finding student whiz kids aides. We met, via modem a local college student who did volunteer consulting one afternoon a week. His help was invaluable. It is important that you keep a log of specific problems and questions. Be specific and accurate since computer types don't automatically understand the terms of the novice. They are also not aware of the specific needs of the handicapped.

Problem: Slow student response time.

Solution: This was partially minimized by Express 3 capability of storing sentences which can be sent in one stroke. A more acceptable solution was found in purchase of communications software with built in text editor. This allows our students to prepare messages off line for quick transmission.

We have students using home computers in much the same way as at school. Parents and family are enthusiastic. We hope to institute a summer school via modem. Extending time on task is an accepted method of increasing student achievement. Providing access to educational programs via modem will involve students during weekends, holidays, and summer break, times when many disabled students are often idle through no fault of their own.

Receiving college credit via telecommunications is already a reality. A San Francisco firm, Telelearning, offers over 170 courses. Students purchase a knowledge module containing modem and communications software and then receive a course catalog. Costs are $90 for module, $35 per credit hour, $30 telecommunication fees per course plus text books and materials.

Recently, several colleges and universities have begun to pursue online education through Telelearning's communication technology. They include the University of Nebraska, Ohio University, San Diego State University, the University of Wisconsin, American Open University of the New York Institute of Technology, DeAnza College of Cupertino, California, and Central New England College in Worcester, Massachusetts. Other colleges and universities have expressed varying degrees of interest in the program.

Technically, each school will develop its courses, then forward them to Telelearning to be incorporated in the online network. Gordon stresses that courses offered by participating universities and colleges are not designed by Telelearning, but rather are products of each school and are delivered via the Telelearning network. Credits are received from the participating school.

In addition the standard software, Telelearning also offers a "Course Translator System" which enables instructors to prepare their courses in English, French, Japanese or other spoken language, and for the student's computer to secure output in standard machine code which then becomes English.

Another firm previously involved in correspondence courses, National Education Corporation will offer 2 year associates degree programs costing from $500 to $200.

Electronic learning is rapidly expanding. Corporations, colleges, and universities are becoming involved. This is an area of promise for Physically Handicapped students. The potential education and vocational benefits are great.

We feel that now is the time to prepare Physically Handicapped students to take advantage of these opportunities. They are learning skills which will enable them to independently pursue job training in those technological areas which will be developed in the 1980's and 1990's.

References

Magnin, Ed., "Getting Hooked on Data Communications," Nibble Magazine, March 1984, pp 110-111.

Moss, Carol, "The Electronic University" Volume 1 #3 Link-Up, Sept. 1984.

Pantiel, Mindy and Becky Peterson, "Compuer Jobs: Where, What, How Much," Family Computing, April 1984, p. 49.

Sims, Robert, "Home Telecommunications," Computers Gazette, May 1984, pp. 95-96.

Schulman, Roger, "Tele Learning-The Computer Brings the Classroom Home," Family Computing, Sept. 1984, Volume 2 #9.

Springer, P. Gregory, "Choosing Your First Bulletin Board," Family Computing, Aug. 1984, pp. 31-32.

"T is for Telecommunications," Popular Computing, July 1984, pp. 105-163.

Tabler, Florenc, "Computerized Bulletin Boards," Microcomputers in Special Education, p. 69.

"Teletellers, Money, Modems," *Softalk*, March 1984, pp. 83-84.

Wollman, Jane, "A No-Hassle Way to Shop?," *Family Computing*, Dec. 1983, pp. 55-57.

Very Low Cost Application Of Talking Bar Code Technology Combined With Pictorial And Alphabetic Language Symbols

John Curran
Tiger Communication System, Inc.
Rochester, NY

Storage of speech data in computer memory chips may have inadvertently suppressed the growth and acceptance of portable augmentative voice output devices. Current augmentative speech aids with lexicons exceeding one thousand words range in price from over seventeen hundred to six thousand dollars. Prohibitive costs, prerequisite user/trainer skills and relative fragility render many of these devices unrealistic for individualized application in a variety of situations. Representational language pictures, a mainstay for many handicapped communicators, are either absent from these devices or limited to the available number of the unit's keyboard or touch-sensitive grid spaces. This article will describe a practical and inexpensive alternative to these problems. It will discuss the interface of the talking bar code technology of Texas Instruments with the language symbol organization of the Tiger Communication System's Tigerbook.

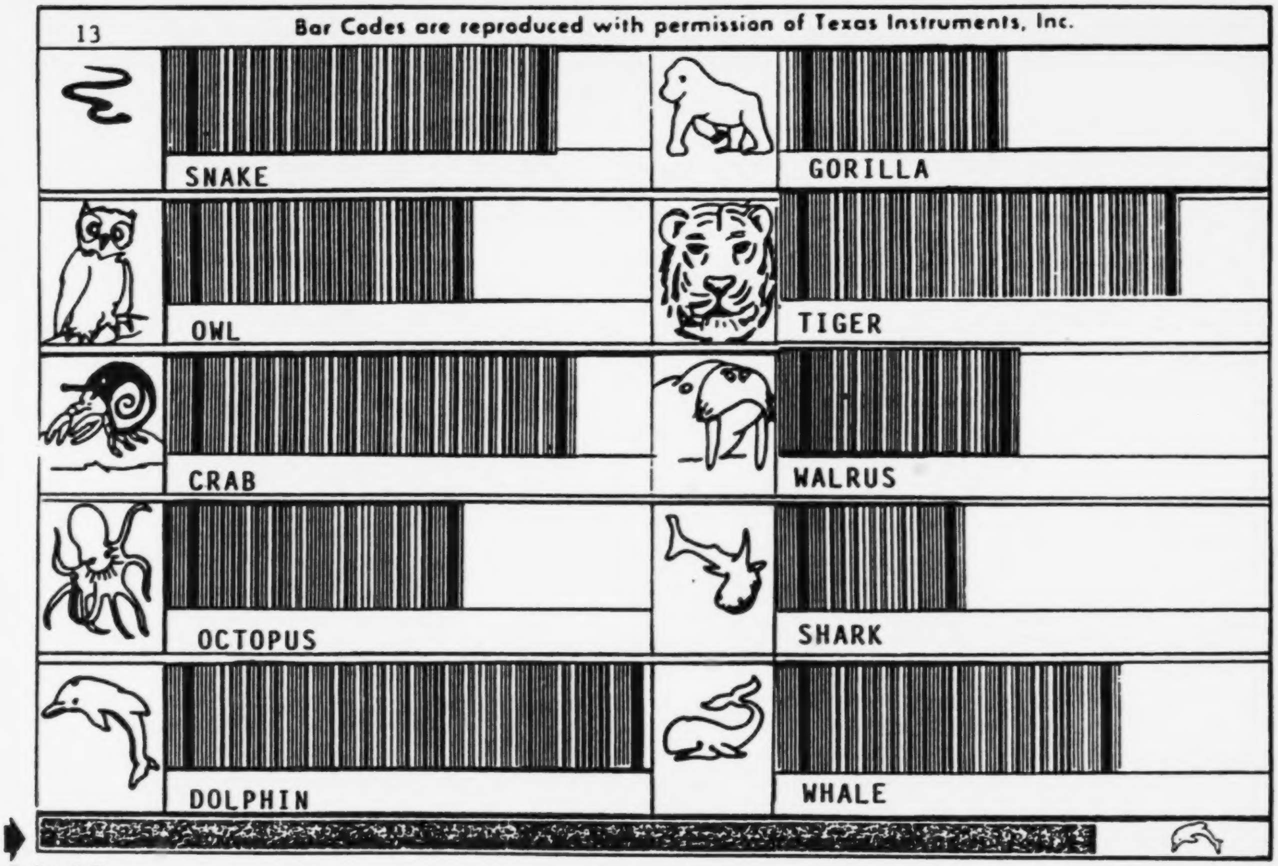
Bar codes are visual representations of binary code data (Pilgrim, 1985). Binary digits are assigned to the patterns of bar code stripes which typically resemble the familiar supermarket UPC bar codes. Storing information in printed bar code form is a flexible and less expensive alternative to the storage of data in custom-made computer chips. Information dealing with speech sounds can be encoded and stored in bar code form in the same way as alphanumeric data. Variables such as pitch and inflection can also be processed within the database to yield a more human-sounding voice. Bar codes are "read" by guiding a hand-held wand or some other bar code scanner across the bar code surface. The wand beams a light source onto the code which is absorbed by the black bars and reflected back to the scanner by the white spaces. These patterns are converted into electrical impulses which travel to the bar code reader's microprocessor. The encoded speech information is then produced electronically through a speaker or earphone. Scanning bar codes is a quick and efficient method of automatic data entry (Baker, 1985). It does not require the use of a keyboard. The code themselves function as software excerpts that tell the microprocessor what to do or say. Bar codes constitute a unique form of software that is best understood as "printware." Printware makes it possible to blend, on paper, machine-readable binary codes with printed words, representational language symbols and pictures. The simplicity of keyboard-fee access to electronic speech output makes the talking bar code technology a practical tool for home instruction and the self-training of BlissmybolicsTM, RebusTM, pictorial language systems and sight vocabulary. Trimble (1984) reports the use of talking bar codes for the training of Braille.

Texas Instruments has developed a popular series of talking learning aids for children based on the successful Speak & Spell and the Touch & Tell. The Vocaid, an upgraded derivative of the Touch & Tell, is an augmentative communication aid developed by T-I. Each of these devices relies on a limited or "canned" vocabulary encoded in computer memory chips. In 1982, Texas Instruments introduced a radically different talking learning aid called the Magic Wand Speaking Reader. The Magic Wand pioneered the use of proprietary bar codes which encoded and stored information as well as data that enabled the user to play a variety of interactive educational games. The T-I bar codes, known as Talking Tracks, originally appeared in a series of colorful and imaginative children's books which sold initially for about $14 a piece. The books served as the printware for the Magic Wand and they contained stories, games, music and sound effects. The 11" x 2" Magic Wand resembles a disc with a built-in handle. It operates on four "D" cell batteries or optional AC-adapter (T-I #9199A). Studies conducted at the University of Arkansas at Little Rock (VanBiervliet, 1985) report that the light weight (3.1 lbs.) Magic Wand can operate for up to 27 hours of continuous battery power usage and that it remains functional within temperature extremes of at least 20 degrees to 140 degrees F. Poor consumer demand for the Magic Wand as a learning aid has lowered its cost to around $40 at present.

The database developed by Texas Instruments to generate talking bar codes incorporates speech sounds as well as pitch and inflectional information. T-I encoded 128 speech segments called allophones within a single ROM (Read-Only Memory) chip. The binary data contained in the bar codes matches up with the encoded speech segments and is then synthesized to produce speech sounds. The hand-held scanner of the Magic Wand contains a fibre optic system which beams an invisible infrared light. A whisking left-to-right scan of the Talking Tracks triggers the voice output instantly through the Magic Wand's built-in speaker or optional earphone. Surprisingly, the Talking Tracks bar codes remain machine-readable when photocopied. They can even be enlarged several times as long as the ratios between the bars and the bar widths themselves remain constant. Care must be taken to ensure that the photocopies are crisp in detail and have a high carbon content for proper reflectivity. Texas Instruments, Incorporated has given permission for the reproduction of the Talking Tracks bar codes for noncommercial research and communication purposes on behalf of the handicapped (Olsen, 1984). Photocopying enables the language trainer to focus on isolated words excerpted from the longer bar coded sentences.

TIGERbook page sample

PAGE
SIZE 5¼" x 7"



13

Bar Codes are reproduced with permission of Texas Instruments, Inc.

COLOR-
CODE BAND

Icon (semantic
category cue)

- USED AS AUGMENTATIVE SPEECH/EARLY READING SKILLS SOFTWARE WITH TEXAS INSTRUMENTS' **Magic Wand • Speak&LEARN**™

-80 pages of survival sight vocabulary

-1,000 word samples

TIGER FORMAT/MINUS BAR CODES/COPYRIGHT 1984

TIGER Communication
System, Inc.
155 East Broad St., #325
Rochester, N. Y. 14604
(716) 454-5134

The Tigerbook is the most recent development of a project, conducted within the Rochester (NY) City School District, whose goal has been the creation of a simple survival vocabulary communication book for nonspeaking severely retarded students. The acronym Tiger stands for Totally Integrated Expressive Reference. It is a comprehensive language symbol vehicle with a lexicon of approximately one thousand words. It is used for language symbol training and expressive communication purposes (Curran, 1985). The Tigerbook features a "word cell" approach which means that each word has an individual language picture, upper-case spelling and a Talking Tracks bar code used with permission from Texas Instruments. The Tigerbook's standard hardcover (9" x 12") binder, divided into left and right halves, contains eighty page sides of language information. Each page side (5-1/4" x 7") displays either ten or fifteen word cells depending on syllabic length. Each half of the binder has twenty double-sided pages. A thin wire rod axle is affixed to the horizontal top edge of each double-sided page. This enables the pages to hinge upward and also to be detachable from the binder itself. The pages lay atop one another in a gently-sloping stack which affords a highly efficient use of three-dimensional space. A thin strip is visible at the page's bottom (and also at the top of the reverse page side). This space is reserved for a color strip designating any one of the seventeen different semantic groupings included in the Tigerbook. Addi-tionally, a tiny picture called an icon occupies the edge of the color strip near the book's spine. The icon provides a simple hint regarding the contents of the page which remain hidden from view until the page is lifted. The semi-rigid Tigerbook pages plus the flip-upward fea-ture make the individual pages easier to manipulate.

The detachable-page option of the Tigerbook makes it possible for the language trainer to add or subtract pages based on the learner's level of language competency. Detachability enables the trainer to photocopy the word cells for the purpose of creating other flexible printware formats such as communication boards, work sheets and flash cards. In a similar vein, Bruno (1984) describes the practical application of Talking Tracks within a personalized communication book.

Artist John A. Trippe, Jr. created an original series of over nine hundred visual language pictures for the Tigerbook project. The simple line drawings, designed to appeal to young and old alike, emphasize concreteness and imitable body language. Abstractions were avoided whenever possible. Learners are encouraged to mimic the body language model as a step towards the comprehension of the language concept. This "going through the motions," under the guidance of the language trainer is intended to replicate some of the processes associated with normal child language development.

The Tigerbook is unique among augmentative communication software offerings because of its multi-symbolic and multi-sensory presentation of a comprehensive survival vocabulary repertoire. It pictures, words, color strips and icons all provide meaningful visual language information. The talking bar codes, augmented by the user's own attempts at speech production, supply the auditory component. The physical act of reaching towards the language picture which serves as a starting point, followed by the motoric sweep of the scanning process, both provide kinesthetic and tactile engagement. Scanning involves visual attending skills, hand-eye coordination and auditory discrimination of the voice output. Physical coordination problems associated with scanning can be ameliorated by tilting the pages at an angle that respects the left- or right-handedness of the user. Channels to guide the bar wand tip can be created with simple self-adhesive label tapes.

The Magic Wand can serve as an extremely low cost speech prosthesis in its off-the-shelf form (Grady, Judge, McCarthy and Mills, 1985). It can serve as a stimulating communication aid within speech therapy applications (Kempf, 1984). The Magic Wand does not represent a huge investment in augmentative communication hardware that must be locked-up overnight at the therapy setting for safekeeping. Its current affordability makes it possible to equip an entire classroom at a reasonable cost. Its toy heritage has kept its cost low; its operation simple, and its construction very durable. It is ideal for language development at home. Its simplicity reduces training time for both user and trainer.

The components of the Magic Wand can be modified and adapted to enhance its performance as a dedicated communication device (Van-Biervliet, 1985). The Tiger Communication System has modified the arrangement of the main circuit boards of the Magic Wand, batteries and speaker components to fit in a project box measuring 3" wide x 6" long x 1.84" deep. The required momentary on/off switch, battery compartment, current-limiting resistor and jack (for battery-recharging) can be purchased at stores for electronics hobbyists. Nickel-Cadmium batteries, a wall outlet charger unit and a carrying strap are recommended. These modifications do require soldering skills and serve mainly a cosmetic function at present. Research and development is needed to enhance the function of the Magic Wand in its new role as a communication and rehabilitative device.

In summary, the ingredients are present today for the practical application of talking bar code technology on behalf of the handicapped. It can be accomplished in a very low cost manner using the hardware of the Magic Wand learning aid with the comprehensive language symbol software of the Tigerbook. Development of this technology is needed to address the low-cost end of the communication aids spectrum where there is a dearth of available portable voice output devices.

References

Baker, E. (1985). Industry Shows Its Stripes. (pp. 13-30). New York, NY: AMA Membership Publications Division.

Bruno, J. (1984). Texas Instrument's Magic Wand: A talking communication book for Stephen. Communication Outlook, 5, (4), 10.

Curran, J. (1985). Low cost portable speech synthesis system using bar code technology. In, M. Gergen & D. Hagen (Eds.), Computer Technology for the Handicapped (pp. 101-105). Hutchinson, MN: Crow River Press.

Grady, J., Judge, J., McCarthy, B. & Mills, N. (1985). Developing a communication prosthesis for mentally retarded adults. In, M. Gergen & D. Hagen (Eds.), Computer Technology for the Handicapped (pp. 48-55). Hutchinson, MN: Crow River Press.

Kempf, C. (1984). The Magic Wand in public school speech therapy. Communication Outlook, 5, (4), 10.

Pilgrim, A. (1985). Bar code bonanza. PC World, March 1985, 198-207.

Trimble, J. (1983). "Magic Wand": The Braille teacher. In, S.P. Todd (Ed.) Rehabilitation R & D Progress Reports: 1983 (pp. 106-107). Washington, D.C.: Veterans Administration.

VanBiuervliet, A. (1985). An inexpensive Bar code reader system for obtaining information from "print." In, RESNA Proceedings 1985. (pp. 254-256). Bethesda, MD: RESNA.

Acknowledgments

Magic Wand Speaking Reader, Speak & Tell, Touch & Tello, Talking Tracks and Vocaid are all trademarks of Texas Instruments, Inc.

The Tiger Communication System, Inc. is a non-for-profit corporation of the State of New York.

Tigerbook: Copyright 1984 Tiger Communication System, Inc., Rochester, NY - bar codes used with permission from Texas Instruments.

# # #

Strategies To Promote Integration And Acceptance Of Students With Disabilities Among Their Non-Disabled Peers, Using Microcomputers

Donna H. Dutton
Special Education Resource Network
Santa Monica, CA

The microcomputer has many applications in education. Among them is promoting the integration and acceptance of students with disabilities among their non-disabled peers. The three strategies discussed here have been field tested informally. No formal assessment of student attitude has been performed, but observation suggests the viability of the strategies.

Strategy #1: Cross-age tutoring in the Special Day Class with disabled student as computer tutor.

A Special Day Class teacher, with upper grade students who have been assessed as having learning disabilities, emotional disturbance, or mild mental retardation, had been teaching her students to use an Apple IIe computer with a color monitor for over a year. A variety of CAI programs had been used. The teacher had noticed that the students were highly motivated when they were at the computer and that their time on task was greater than when they were performing paper and pencil tasks. The teacher now sought a computer activity which could now enhance her students' self esteem.

Meanwhile, the Kindergarten teacher at the same school had been working with her students on number and alphabet concepts. She wished that her students could have an experience with computers, which were reported to be intriguing. Unfortunately, her students did not have access to a computer.

The special education teacher then made an arrangement with the Kindergarten teacher. The Kindergarten students would come to the special education room, one at a time, one per day, for a computer experience. The Special Day Class students were to act as experts and guides for the younger children. Each SDC student was assigned the role of tutor for 30 minutes per day for one week at a time.

Two pieces of software were selected for this project: Stickybear Numbers and Stickybear ABC. Stickybear Numbers allows the student to press any numeral on the keyboard. Then a set of that number of objects appears in color on the screen. Then a set of that number of objects appears in color on the screen. The objects are animated. If the student then presses the spacebar, the objects disappear, one by one, with each presses. When no object remain on the screen, and the student presses the spacebar, a new set of animated objects begins to appear, one per press of the bar. As objects appear on the screen, the number in the current set is displayed. Thus, this program helps young children to match sets to numerals and to add and subtract by one. In Stickybar ABC, the student is asked to select a letter. As a letter is pressed, that letter appears on the screen and an animated color object beginning with that letter is displayed. Thus, this program helps young children to match letters to initial letters of words. The program is very engaging and requires very few Keyboard skills.

As the Kindergarten students arrived, the SDC students instructed the younger students in the use of the programs and served as guides as the programs proceeded. The Kindergarten children were observed to be fascinated with the computer and engaged in the learning process. The SDC students were observed to be patient and kind. They clearly enjoyed their roles and exhibited no negative or inappropriate behaviors.

There were several interesting outcomes for the Kindergarten students participating in this project. First, they received experience using a computer and practice matching sets to numerals, adding and subtracting by one, and learning about letters and initial sounds of words. They had fun. They learned what a special education classroom is like, and that it is a "nice place." They learned that "special education" students can be helpful and capable. Finally, they experienced a feeling of elevated self-esteem for having been "chosen" for the computer experience.

For the students with disabilities, there were also several positive outcomes. First, they had positive experiences with nondisabled students. They practiced "being successful," while, in the past, they had frequently experienced failure. They enjoyed the role of the trusted and capable "computer expert," and their self-esteem then began to rise.

There are several points to remember when replicating this project. First, the tutor should be older than or the same age as the student he/she is tutoring. The student from the regular class needs to be less experienced at using the computer than the tutor. The positive outcomes for the student in special education will not result if the roles are reversed and the student from the regular class becomes the tutor.

Any computer program which the student with a disability has mastered would be appropriate for use with this strategy. The program simply must be viewed by both students as worthwhile and fun.

Strategy #2: Using a simple data base management program to focus upon similarities between students in regular classes and students with disabilities who are mainstreamed in those classes.

Dr. Lynn Fox of Cal State, San Diego has developed a series of materials based upon the premise that a student with disabilities is more likely to be accepted in the mainstream if he/she has just one friend who is well accepted in the class. Such friendships are likely to evolve when students view each other as having preference in common (Fox, 1984).

In this case, the setting is the regular classroom, where a single computer is located. For this specific project, it was a second-third grade class in which there were students with learning disabilities and one student with mild mental retardation. All of the students were having their first year of experience with the computer.

The software selected for this strategy was PES: File, a very simple data base management program. Actually, any simple data base management program could be used for a project like this one. Working as a "committee of the whole," the class designed the form to be used for a data base called "Our Class." The class selected the following fields for their form:

Name
Country of Birth
Languages
Street
Birthday
Favorite Ice Cream
Tennis Shoes (Y/N)
Hobbies
Eye Color
Favorite Story
Favorite TV Show

Working in pairs, the students entered all of the relevant data, with the help of a parent volunteer. Finally, the data base was complete and information was available on each member of the class. Students returned to the computer in groups of 2 to 4, again with the help of a parent volunteer. The students learned to do searches. For example, they searched for all class members who preferred chocolate ice cream and for all class members who liked to watch "Tom and Jerry" on TV. Searches were printed out, and the teachers used the retrieved data for lessons on creating graphs. Students with disabilities were grouped with well-accepted students.

There were several positive outcomes for the non-disabled students. First, they learned about the concept of the data base as a useful tool. During the search phase, they learned that students with learning disabilities or mental retardation share their likes and dislikes and consequently are more "acceptable." They also viewed the students with disabilities as competent and capable because they could use the computer. Finally, the students had positive feelings about being asked about themselves and their preferences.

For the students with disabilities, there were also positive outcomes. First, they, too learned about data bases. They perceived themselves as capable because they were able to use the computer. They had positive interaction experiences with the non-disabled children, which had not always been the case in the past. They, too, felt good about being asked about their preferences, and saw that they had interests in common with many children.

In addition, some unexpected outcomes resulted. There were similar benefits for other groups of students who frequently experience a sense of isolation: minority students, ESL students and quiet, withdrawn students.

We do not know if this project actually led to better relationships and new friendships in the class, but we can surmise that these would be likely. The teacher felt that it was a worthwhile experience.

Strategy #3: Using the computer as a prosthesis to allow students with physical disabilities to function in the regular classroom.

In this case, an informal experiment was conducted with a 7th Grade student with Cerebral Palsy. This student has severe motor impairment. He had spent his life in a wheelchair, has very little use of his hands, and has speech which is difficult to understand. His parents were anxious for him to have some integration experiences with his non-disabled peers in the regular classroom. They knew that he was cognitively capable of the work in the English class, but felt a degree of skepticism on the part of the staff.

This student brought his Apple IIc computer with him to English class. His preferred word processing program is Bank Street Writer. This particular program has a 40-column display which is easy to read and only rarely requires the use of more than one finger at a time. (Other word processing programs could be used as well. The Milliken Word Processing, is also quite simple to use).

This student accesses his computer with a head wand, which allows him to select and press keys on the keyboard by moving his head.

Although this is the preferred method of access for this student, there are many alternative access devices on the market today.

As other students completed their classwork with pencil and paper, the student with Cerebral Palsy used the computer. One lesson was observed in which the students were asked to identify synonyms from among four-word sets. With the word processor, this student could write his answers to the screen, and ultimately, to a printer. He required help managing papers, and for this an aide was available. Other students helped as well. The teacher was patient and understanding.

When this strategy is used, there were several positive outcomes for the non-disabled students. First, they had the opportunity to see someone with Cerebral Palsy as intellectually capable. They got a chance to know him and to interact as equals. They learned that students with Cerebral Palsy are people first, and are able to function in many ways despite their physical limitations.

For the student with Cerebral Palsy, there were positive outcomes as well. First, he was able to have an opportunity to attend a regular class, learn the content being taught, and to interact with the students. He enjoyed having others view him as a competent individual. The possibility of friendship came into play, whereas that was not possible when he was isolated in a special class. His self esteem was enhanced, as his classmates and the teacher learned about his abilities, his ideas and his feelings through his writing.

Conclusion: Microcomputers are so highly motivating and "socially acceptable" that they can become tools in the process of bringing children together. The strategies discussed are but a few of many approaches which could be employed to promote the integration and acceptance of students with disabilities using microcomputers. These can be used in mainstream as well as in reverse mainstream solutions. It is, of course, critical that classes for students with disabilities be located on regular campuses if any of these strategies is to be employed. The potential for positive outcomes for everyone concerned makes it worthwhile for educators try these and other similar methods.

References

Falvey, M.A. (1985). Community Based Curriculum: Instructional Strategies for Students with Severe Handicaps. Baltimore: Paul H. Brookes Publishing Co.

Fox, L. (1984). Social Acceptance: Key to Mainstreaming. Rolling Hills Estate: B.L. Winch and Associates.

Osguthorpe, R.T. (1985, September). Trading Places: Why Disabled Students Should Tutor Non-Disabled Students. The Exceptional Parent, 41-48.

Software

Bank Street Writer, Broderbund Software or Scholastic, Inc.

PFS: File, Software Publishing Company or Scholastic, Inc.

Stickybear ABC, Xerox Educational Publications

Stickybear Numbers, Xerox Educational Publications

Credit should be given to the following teachers in the Santa Monica-Malibu Unified School District: Mike Hepburn, Anne Joy, Marie Kincannon, Chris LeGagnoux, Carol Neel, John Schlanger and Patricia Weideman.

# # #

Speech Synthesis As A Teaching Tool

Farah Fisher
Los Angeles Harbor College
Wilmington, CA

One of the most exciting aspects of the advent of the microcomputer for education has been the ever-increasing variety of input and output devices. Computer-assisted instructions (CAI) in the "good old days" (before 1977) was usually limited to drill -- the computer typing a problem on paper or a screen and the student responding on a keyboard. In some cases this was effective, but hardly exciting! These days a computer might display a problem in animated pictures, music, or spoken by a robot voice. The student can respond with a joystick, touch screen, graphics tablet, mouse, voice input -- or maybe even an old-fashioned keyboard. Quite a change in less than 10 years!

Many have questioned whether these technological advancements have improved the quality of educational programming. In some cases the authors at CAI have seemingly added graphic or sound displays only for a novelty effect -- they appear to have little to do with the instructional process or content being presented. The recent popularity of video games undoubtedly influenced the publishers a great deal.

If novelty is to be discounted, of what good are these new devices? Those who work with disabled students have been slowly discovering the great potential of these developments for special education and rehabilitation. A joystick may make math drill more fun for some students, but for an individual with limited arm movement it becomes a necessary part of computer use. Listening to speech synthesis may inspire some to joke that the "Cylons" are coming, but to a visually impaired or learning disabled student it may make life a great deal easier.

The particular enhancement which is the topic of this presentation is the production of speech (through a synthesizer or a cassette control device). The need for speech or other sound in addition to a visual computer display is not reserved for the blind; any student with reading difficulties may benefit. If information is presented on the screen in an educational program, it is of little use to the student who can't read it. If a student is doing well and the screen displays the word FANTASTIC, the value of the positive reinforcement is lost if it cannot be understood. The blind programmer, the student who does not read English ... the list goes on.

The technology of speech production has improved greatly in the last two years. At present there are several relatively inexpensive speech synthesizers, available for almost any microcomputer. The quality of the speech varies greatly, but all is within a tolerable range. The alternative -- cassette control device (CCD) -- utilizes human speech recorded on and off under computer program control. The speech synthesizer, on the other hand, changes words into "sound pictures" according to built-in rules or uses pre-set word sounds. Both methods of speech production, happily, are very easy to use, requiring little or no knowledge of programming. Programs are usually included when the devices are purchased that may be used alone or incorporated into other programs.

The ECHO II/ECHO+ Speech Synthesizer

Both the recently developed ECHO+ and the older ECHO II synthesizers can be easily installed and come with disks full of useful programs. The ECHO II has a "robotic" voice for unlimited speech and the capability of producing words by combining phonemes. The ECHO+ adds a second voice (better quality but with a limited vocabulary) as well as music and sound effects. The ECHO+ requires an APPLE IIe (with an extended 80 column card) for the second voice. The program disks each contain a program to enable the unlimited speech -- in other words, to read whatever is printed by a program in normal type (not graphically produced type). The command BRUN ECHO (for the ECHO+) or BRUN TEXTALKER.BLIND (for the ECHO II) can be added to any unprotected APPLESOFT BASIC program.

For example, if you have a public domain program (such as ASSERTIVENESS TRAINING) that depends on a great deal of reading and a multiple choice response, a visually impaired or learning disabled student would need a reader in order to use it. A student with reading problems might not be able to understand the feedback from a math drill or a business simulation. When the TEXTALKER.BLIND file is transferred to the disk and the command BRUN TEXTALKER.BLIND (actually PRINT CHR$(4); "BRUN TEXTALKER.BLIND") is added to the program, the computer pronounces all words printed on the screen. If you have APPLESOFT programs stored on a PRODOS disk (APPLE's new operating system, the ECHO and ECHO2 files would need to be used in place of TEXTALKER.BLIND.

There are several cases in which the TEXTALKER.BLIND program will not read all printed text. As was previously mentioned, only normally printed text can be spoken in this manner. If a program (e.g., BANK STREET WRITER) uses graphics to produce letters, the speech will not be run. Sometimes graphics displays at the beginning of a program will inhibit speech production. Copy-protected programs which must be "booted" to start will also not work. INTEGER BASIC programs (when run on the APPLE IIe) do not support speech. The best type of program to experiment with when beginning is any public domain APPLESOFT BASIC program. These are not copy-protected and can be easily changed.

One of the most useful computer applications for college students is word processing. Since no word processing program available at Harbor College could be made to produce speech, a test generating program was converted. It has not been thoroughly tested as yet, but should be polished soon. The program uses a menu to read choices to students, and editing is done by the line. For those who have used WordStar (or even Bank Street Writer), the process may seem tedious. For the visually impaired student, however, reading back the text should prove very helpful. A copy of the program can be obtained by sending a blank disk to Farah Fisher at L.A. Harbor College.

The first program we used with learning disabled students was the SPELLING TEST program on the ECHO II disk. Instructors enter and edit word lists, typing both the correct spelling and the proper pronunciation of each word. Students type their names and take the spelling test -- the synthesizer pronounces each word. We assumed that the spelling drill would be the most useful aspect of the program. As it turned out, the necessity for the students to spell their names phonetically was a valuable lesson. The reinforcement sometimes included their name; the challenge was to spell it so that the computer would not mispronounce it. With the ECHO's tendency to have trouble with "G's" Greg turned out to be GHREGHGG!

The main difficulty with the ECHO series (unlimited speech) is that it is sometimes hard to understand. The ECHO+ fixed vocabulary voice is much clearer, but is limited to 725 words (though this list may be extended through the use of some affixes). The main advantage is that (given the proper programs) it can read virtually anything.

The Cassette Control Device

An alternative speech production device is the Cassette Control Device (CCD) from Hartley. This small connector plugs into the Game I/O port of Apple II, II+, and IIe (not IIc however). It does not, by itself, produce speech; it merely turns on and off a tape recorder (when plugged into the REMOTE port of the recorder). Since it uses human-recorded speech, the quality is obviously better, takes a bit of doing. Two simple commands are used to program the electrical current switch to the recorder -- POKE -16295,0 turns it on and POKE -16296,0 turns it off. Timing can be controlled with FOR/NEXT loops. Since it is sometimes difficult to position a tape at exactly a certain spot, it is recommended that a separate tape be used for each program (so that it can be rewound to start at the same place).

Besides the positioning problems, another difficulty arises in CCD use. Many drill programs use a random function -- different problems each time. There is no way to pre-record the problems for later playback. The CCD could be used for instructions, however. Again, copy-protected programs would be difficult (or impossible?) to adapt.

Several programs are available from Hartley which allow the teacher to take easy advantage of the recorder control without any programming knowledge. One example is CREATE-SPELL IT. The program guides teachers in setting up spelling lessons, making tapes, and keeping track of student records. Because of the initial placement timing problem, it is recommended that each lesson be kept on a separate tape. When a student takes a test, they must rewind the tape and press the PLAY button before beginning. The tape recorder comes on at the appropriate time with whatever spelling word and sentence the teacher previously recorded. When the student responds, a graphic indication of right or wrong is shown on the screen. The number of tries before the correct answer is given is teacher-controlled. At the end of the lesson, a chart of the student's score is shown. Teacher reports include a list of missed words and the incorrect tries. This can be especially helpful for teachers of the learning disabled or bilingual students.

If you want to add speech to your instructional programs, which method should you choose? It depends on whether you feel that speech quality is more important than flexibility. For instructions to be given only at the beginning of a program simply turning on a tape recorder (without a CCD) should suffice. For randomized drill, a synthesizer would be more appropriate. For many commercial programs, neither device works. If either device is purchased, time is needed for exploration on the part of the teacher. Obtaining a disk with ready-made programs will make the technology immediately useful during the trial period. Whatever the decision, speech can enhance your students' chances of learning.

ECHO+ & ECHO II Speech Synthesizers
Street Electronics
1140 Mark Avenue
Carpenteria, CA 93013

Cassette Control Device, Create-Spell It Program
Hartley Coursewarre, Inc.
Dimondale, MI 48821

# # #

The Use Of Microcomputers In Program Evaluation

Colleen Fitzpatrick
CSUN National Center on Deafness
Northridge, CA

High technology and the use of computers has become an inevitable and integral part of the work environment on virtually all occupational levels. The human services industry is no exception. The microcomputer has made available the ability to organize large volumes of information. This availability of information has led to a demand for quantitative analyses in an attempt to evaluate the effectiveness and efficiency of program delivery. In addition, the Federal, State, and Local governments have begun calling for indepth reports in their attempts to insure accountability in government funded programs. Not only does the microcomputer provide the ability to organize and sensibly present data, it also makes available a dynamic tool for developing methods by which human services professionals can internally evaluate the effectiveness of their own programs. The microcomputer then, provides the individual Evaluator with resources for information access, data organization, data analysis, manuscript preparation, graphics design, and statistical analysis. These capabilities were available only to mainframe users less than a decade ago.

There are an uncountable number of software packages available for the microcomputer today. The three which I find meet most of my needs, as a Program Evaluator, are Wordstar for manuscript preparation, SPSS/PC for statistical organization of data, and D-base III for data tracking and storage. There are many types of software packages available which makes it possible for anyone to easily create and manage data and definition files for statistical analysis and report presentations. The microcomputer also makes it easier to create surveys, data forms, and other data collection tools in a well formatted and easily revised manner.

What microcomputers can and cannot do is largely dependent on the type of micro used and the person using it. In general a micro can:

1. Act as a word processor with comprehensive editing and formatting capabilities. With supplemental programs it can also check spelling and manage mailing lists.
2. Maintain and access 500 to 2,000 data records (depending on record size) on floppy diskettes and much more on hard disks.
3. Do any statistical analysis on data sets, the size of which varies depending upon the software used and the disk storage capacity.
4. Be programmed in almost any programming language, including BASIC, FORTRAN, and COBOL.
5. Function as a dummy terminal for transfer of files to and from a mainframe.
6. Produce statistical graphics and plots.
7. Monitor and operate laboratory equipment and other physical devices.

In general a microcomputer cannot:

1. Do anything unless it has been told to do something via a program.
2. Use many mainframe statistical programs, although many of these programs, such as SPSS, have been converted for micro compatibility.
3. Analyze extra large data sets. For example, SPSS/PC version 1.0 has a limit of 2,000 variables with 2,956

values accumulated across all variables.

4. Understand speech input without special software which is still in the experimental stages and unpredictable.
5. Read printed or handwritten text reliably.

There is limited typed print read capabilities, but again, this capability is still in the experimental stages.

As you can imagine, the ability to use a microcomputer helps to facilitate any evaluation task. Plus it greatly assists in storing information which can be accessed readily for referencing and future analysis. This is only a few of the many ways in which a small to moderately-sized organization can take advantage of modern technology in getting its data analysis and evaluation needs met in a timely and reliable manner.

In conclusion, it can readily be seen that the ability to use microcomputers in the evaluation of program delivery and the tracking and organization of data can become an invaluable asset to any type of human services program, regardless of the disability served. With the increasing demand for quantitative information on the Federal, State, and Local levels, as well as for an organization's internal purposes, the use of microcomputers will very likely come to occupy a cost effective, permanent, and valuable position within the Human Services system.

References

Madron, T.W., Tate, C.N., and Brookshire, R.G. (1985). Using Microcomputers in Research. Beverly Hills, CA: Sage Publications, Inc.

Norusis, M.J. (1984). *SPSS/PC: SPSS for the IBM PC/XT*. Chicago, ILL: SPSS, Inc.

Schrodt, P.A. (1984). *Microcomputer Methods for Social Scientists*. Beverly Hills, CA: Sage Publications, Inc.

Trochim, W.M.K. (1984). *Research Design for Program Evaluation*. Beverly Hills, CA: Sage Publications, Inc.

Wolverton, V. (1984). *Running MS DOS*. Bellevue, WA: Microsoft Press.

# # #

Dexter: A "Talking" Hand For The Deaf-Blind

Deborah Gilden
Smith-Kettlewell Eye Research Foundation
San Francisco, CA

Computers have been a wonderful tool for helping many disability groups to become part of the educational, social and vocational mainstream. For example, we are starting to see blind people in the workplace using computers, nonvocal individuals equipped with "talking" communication aids are venturing out into the neighborhood, and deaf people are making more telephone calls as general TDD (telecommunication devices for the deaf) numbers are becoming more commonplace for various agencies and commercial organizations.

There remains, however, a group of disabled people who are especially isolated and for whom standard computer displays or synthetic speech output is of no help. This group comprises those individuals who are both deaf and blind. Without either the auditory or visual channels for receiving information, these people are pretty much restricted to their sense of touch to know about the world around them or to receive communication.

The One-Hand Manual Alphabet

There are several different tactile communication systems which enable deaf-blind people to receive interpersonal communication. A common system in the United States is the "one-hand manual alphabet" shown in Figure 1. It consists of twenty-six different hand configurations, each one representing a letter of the alphabet. Deaf people "read" the manual alphabet visually, and deaf-blind people "read" it tactilely. While this tactile finger spelling is most important to many deaf-blind people, it is not without its drawbacks. It requires the person transmitting the information to be familiar with the manual alphabet, thus tremendously limiting the number of people available for communication. In addition, the physical contact required by tactile finger spelling puts the deaf-blind person in a very dependent position, and at the same time may be very demanding on the time and physical freedom of the sender. Another problem is that transmitting information via finger spelling is very tiring after a short period of time. There are professional interpreters who are highly skilled at tactile finger spelling and can do it for surprisingly long periods of time, but the cost of employing them tends to be an expensive luxury for most deaf-blind people who, as a group, tend to be unemployed.

The isolation experienced by deaf-blind people is not restricted to interpersonal communication. Unless they know braille (and the majority do not), they are also unable to access written materials independently. Currently, an interpreter must read the information for the deaf-blind person and then transmit it directly to his hands through finger spelling or signing.

Dexter, the Mechanical Finger Spelling Hand

In order to help deaf-blind people become more independent in their quest to receive information, the Smith-Kettlewell Rehabilitation Engineering Center sponsored a class project which was conducted by four graduate students at Stanford University's Department of Mechanical Engineering.[1] The results is a research prototype mechanical finger spelling hand named Dexter.[2]

With four fingers and a thumb, each appropriately jointed, Dexter looks much like a large, metal humanoid hand. The thumb and the first finger each have two degrees of freedom, and the remaining three fingers each have one degree of freedom. All five digits can assume any of four positions, and the entire wrist can rotate 180 degrees. The rate of letter presentation is variable up to two per second. The hand is currently driven pneumatically from computer input.

Since Dexter is actually a computer peripheral, different interfaces may be developed to address different needs. Given its current simple computer interface, Dexter can enable even finger-spelling-naive individuals to communicate face-to-face with deaf-blind persons simply by their typing a message on the computer keyboard; Dexter will respond by making the corresponding letter shapes of the manual alphabet for the deaf-blind person to feel. If, however, Dexter were interfaced with a TDD, they would be able to communicate over the telephone. Such remote interpersonal communication is of obvious social, vocational, and sometimes even health or safety importance. And, of course, computer access in general has potential to open new vocational as well as vocational doors for this population.

Finally, it is anticipated that Dexter may be a means of allowing deaf-blind people to exercise their literacy. More and more books and magazines are being put in electronic format prior to being printed, thus making them "readable" by Dexter with appropriate interface. That is to say, the hand will spell out the letters of the book or magazine one by one, making this information available tactilely to the deaf-blind "reader." We expect this to be especially important to the largest group of deaf-blind people, those with Usher's syndrome. Usher's syndrome patients are generally born deaf but gradually lose their vision starting in early adulthood. Unless they have applied themselves to the task of learning braille, these people find themselves no longer able to read, let alone receive manual communication visually as before.

Future Plans

Dexter has been designed as a research tool. We have already learned that deaf-blind people really can "read" Dexter, and so far they certainly seem to enjoy doing so.

The students working on this project insightfully incorporated a means of, in effect, freezing any of the fingers or joints desired. The Smith-Kettlewell Rehabilitation Engineering Center will utilize this feature as we investigate the possibility of modifying the manual alphabet to exclude use of the last two digits. For every joint or digit eliminated, the system becomes less expensive. Another advantage of a three-fingered mechanical hand is that three digits are typical of robotic hands designed to grasp objects. Perhaps it will be possible someday to have a multipurpose hand to perform both the motoric manipulation of object and the communication function of manipulating words!

Other parameters which will be researched include determining the optimal speed of the letter presentations, the best material for tactile perception and aesthetics, the most efficient way to drive the system (e.g. with stepper motors rather than pneumatically), how to miniaturize the system, etc.

Thanks to computers, there are other tactile systems which could be developed to achieve Dexter's goal. The more options that are investigated, the more deaf-blind people will be able to live life not as isolated, functionally illiterate people, but rather as independent human beings able to communicate with other human beings no matter how physically remote.

Footnotes

[1] We would like to acknowledge the efforts of John Dunssaert, Alan Greenstein, Patricia Lee, and Alex Meade for their remarkably high caliber work at a breakneck pace; we would also like to thank Dr. David Boonzaier for serving as a most helpful liaison between Smith-Kettlewell and Stanford.

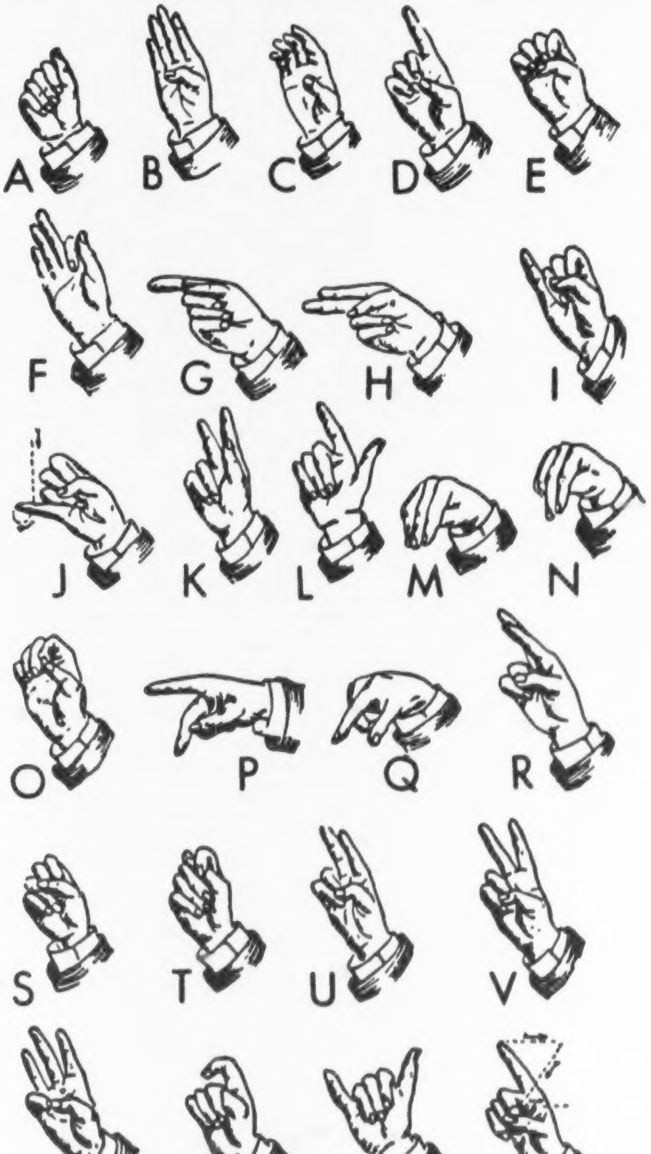
[2] We would like to acknowledge the Southwest Research Institute in San Antonio, Texas, as the originator of this concept, and the developer of the first prototype of "an artificial hand for communication with deaf-blind people" in 1977.

This project was sponsored by DOE - NIHR Grant G008005054.

# # #

77

One Hand Manual Alphabet



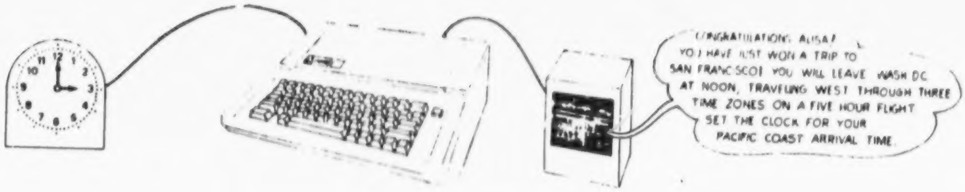
No Monitor Or Keyboard Needed For Computerized Educational Devices For Blind Children

Deborah Gilden
Smith-Kettlewell Rehabilitation Engineering Center
San Francisco, CA

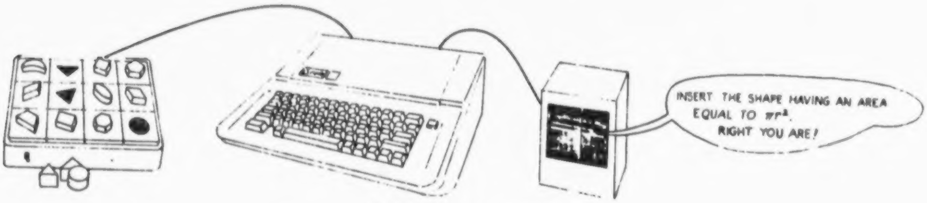
The colorful and dynamic graphics produced by good educational software and displayed on monitors are terrific at instructing and motivating young children -- unless they happen to be blind. Computer keyboards are also useless for the young blind child who has not memorized the keys or learned to read braille. To overcome these problems, yet take advantage of the flexibility inherent in computer chips, the Smith-Kettlewell Rehabilitation Engineering Center has developed several computerized educational games for young blind children, including the Auditory Arcade and the Tact Tell System. Although some of these devices are stand-alone units incorporating a computer chip, and others are special peripherals which interface with a computer, they all require the child to manipulate objects (instead of typing), and they all present problems, answers and reinforcement through music or synthetic speech (instead of monitor displays).

The educational areas which these devices can address are essentially limitless due to their modular nature and the flexibility of computer software. Prototypes built to date may be used to teach skills such as fine motor coordination, texture matching, auditory memory span, and how to read braille clocks. One also introduces new vocabulary, telling the child the names of specific hardware such as "alligator clips" and "banana plug" via synthetic speech in response to correct manipulation of those pieces.

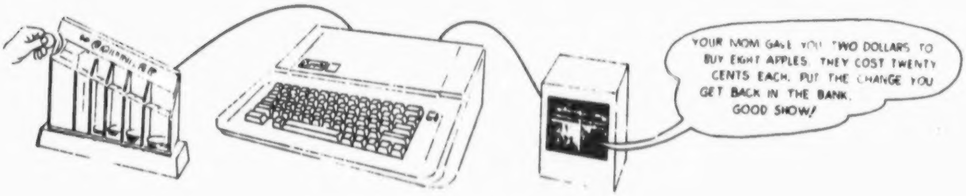
Future versions will include shape recognition, counting money and making change, and possibly even geography through map work. Figure 1 shows how the same general set up can be used to teach a wide variety of skills and concepts by varying the manipulata and the auditory instructions and feedback.


CONGRATULATIONS ALISA! YOU HAVE JUST WON A TRIP TO SAN FRANCSCO! YOU WILL LEAVE WASH DC AT NOON, TRAVELING WEST THROUGH THREE TIME ZONES ON A FIVE HOUR FLIGHT SET THE CLOCK FOR YOUR PACIFIC COAST ARRIVAL TIME.

TACT TELL TICK TOCK


INSERT THE SHAPE HAVING AN AREA EQUAL TO πr². RIGHT YOU ARE!

TACT TELL SHAPES


YOUR MOM GAVE YOU TWO DOLLARS TO BUY EIGHT APPLES. THEY COST TWENTY CENTS EACH. PUT THE CHANGE YOU GET BACK IN THE BANK. GOOD SHOW!

TACT TELL MONEY COUNTER

Another educational game from the Smith-Kettlewell Rehabilitation Engineering Center is an electronic formboard. It provides auditory, visual and tactile feedback when the child inserts the correct shape. This formboard has been shown to be especially valuable for deaf-blind children -- a group for whom precious few educational toys or games are appropriate.

While these various games were developed especially for blind, partially sighted, and deaf-blind children, sighted children also greatly enjoy playing them. The tangible nature of the tasks, along with the "intelligence" of the computer presented through synthetic speech, seem to have universal appeal.

This project was sponsored by DOE - NIHR Grant G008005054.

# # #

Interactive-Observation In Communicative Disorders

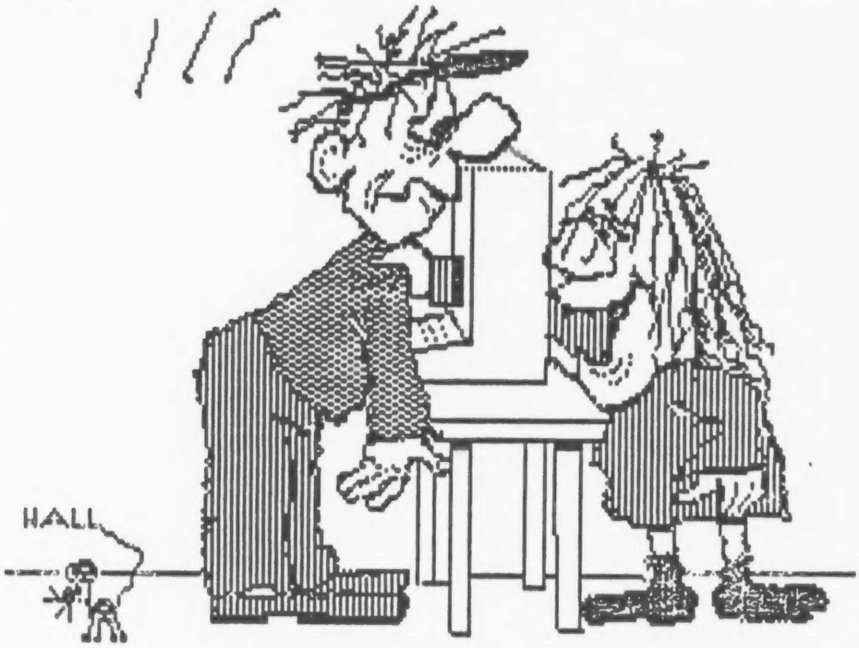
Ed Hall and Ruth Harris
CSUN Department of Communicative Disorders
Northridge, CA

and

Julianna Secor
Sepulveda Veterans Administration
Sepulveda, CA

INTERACTIVE - OBSERVATION
IN
COMMUNICATIVE DISORDERS

Interactive video really grabs Ya!!!



Presented by

Hall, Harris, Secor and Rolls.

Interactive-observation is a new and powerful teaching system which combines the strengths of computer assisted instruction with the graphic realism of television.

Recent advances in the technology of video systems and computer software have presented new opportunities for research into innovative approaches to personnel preparation and the development of materials to prepare personnel to educate handicapped children and youth. In reference to video systems, Thomas and Thomas (1984, p. 28) have concluded that presently, "The most efficient medium for presenting massive amounts of information and examples is videotape." Kaufman and Kaufman (1983) have reported that video instruction is very effective in training medical students, especially in the areas of neurology and psychiatry because it allows the students to actually view patients who have the disorders they are studying. Hence, video instruction improves the quality of education by effectively bringing to students concrete examples of theoretical concepts heretofore inaccessible to them under the typical classroom lecture paradigm. This has particular relevance to the training of personnel associated with the education of handicapped children. In the area of communicative disorders, for example, accurate videotape portrayals of speech-language and hearing problems could readily be transported from special rehabilitative sites to training facilities to familiarize educational personnel with the nature of the disability and strategies for classroom and home management. This enriched curriculum can be accomplished, moreover, without an increase in the amount of time the teacher must spend in instruction.

One major disadvantage of the video recorder, however, is the linear nature of the presentation. An interactive paradigm with horizontal as well as vertical lesson flow is known to be far more effective in teaching. Another major drawback is the passivity or lack of involvement of the students during the viewing process. Experience obtained through the observation program in the Department of Communicative Disorders at CSUN, for example, suggests that without the elements of commitment and feedback, the observers often become careless and inattentive. The lessons are, in addition, inefficient in terms of record keeping, providing written instructions, administering examinations, or giving ready reference to problem areas.

The computer, on the other hand, excels in promoting the elements of commitment and feedback and can easily provide for written instructions, examinations, record keeping and problem analysis. Like the video system, it requires less personal involvement of the instructor as the trainees can individually run their own lessons. Commitment occurs because the student is required to make numerous decisions during the course of the lesson, and the correctness of these decisions is immediately available to the student. Problem diagnosis and assistance is provided by the computer as needed to guide the student toward the proper solutions. The student's progress is automatically recorded on computer diskettes, and computer programs are available for the statistical analysis of this lesson drill and record keeping.

A negative factor restricting the effectiveness of computers as an instructional aid in the areas of speech, language, and audiology, however, is their limited graphic capability to portray language or rehabilitative techniques with any realism. Objects and events can be depicted only in rigid schematic form at considerable cost to the computer's memory reserve. The quality of the audio components, particularly voice, is even more unsuited to the instruction of trainees in specialized fields or of nurses, teachers, administrators or parents from the general education milieu attempting to understand technical information in a special field.

The innovative course of action would be to combine the strengths of the two teaching aids, the video recorder and the computer, to achieve both a realism in the graphics and the involvement of the student. Recent technological advances have now made this feasible. The combined system is referred to as computer assisted video (CAV), interactive video, or as it is called here, Interactive-observation. A computer is connected through special hard- and software to a video player. Hence, the computer controls the tape presented by the video system depending upon the responses of the viewer to the lesson programmed into the computer. It provides immediate feedback, intervention and record keeping services as needed. Dillingham, Roe & Roe (1982) have noted that "Computer assisted video instruction can provide both language (printed on the video screen) image (objects or action recorded on videotape) and the interaction of stimuli (questions on the screen) and response (student inputted answers)" (p. 657). Thus, Interactive-observation, although it is still in the developmental stages, has become a surging educational force in almost all fields including the military, health services, business, industry, and some areas of education (Reilly, 1985). In this training milieu, computers have been aligned with both videotape and/or videodisc recorders. The former is less expensive and readily available to any educational institution. It requires only a computer with a disc drive (e.g. Apple IIe), an interface module, dual audio track videotape recorder, and a video monitor. Its disadvantages, however, include slow information access time, and wear and tear on the active process. They are more durable and have better image clarity. The most important aspect, however, is rapid research time, allowing information to be accessed from anywhere on the disc within seconds." (Reilly, 1985). A major disadvantage has been high initial disc development costs and processing complications. Depending on the premastering costs and content, a 30-minute disc could cost $40,000 and could only be processed by a few special companies. Recent technological advances have drastically reduced this cost with the advent of the "home" disc recorder (developed by Panasonic). Hence, both initial and duplicating costs of video discs are suddenly coming into the range of feasibility for widespread use in the domain of special education.

As computer power becomes available at more affordable prices, it invites careful research as a clinical tool (Fitch, 1985). With the advent of this innovative marriage between the video and microcomputer the basic need becomes one of developing and evaluating an Interactive-observation system in the training of personnel to habilitate communicatively handicapped children.

Advantage of Interactive Video

As computers have invaded the National Educational scene and paved the way for interactive machine teaching, the potential for Interactive-observation to have an impact is equally as great. The National Center of Educational Statistics in the U.S. Department of

Education reported that in 1982, one in three public schools had computer facilities, and by 1985 the number of computers in the schools was estimated to have doubled (Aeppel, 1983). Locally in the Los Angeles Unified School District, according to the Superintendent's Office, there are nearly 2,500 minicomputers in use for staff development and instruction. If Interactive-observation Learning Centers are demonstrated to be effective and feasible, they may be the next inexpensive step toward achieving new levels of excellency in teacher inservicing and preparation.

Interactive-observation Learning Centers would benefit education at all levels from the individual being trained to the training institutions themselves in the following ways:

Benefits to the Trainees:

More Information Available: Interactive video provides a powerful information tool. A standard 12 inch disc contains 54,000 single frames per side enabling large quantities of data to be manipulated (Reilly, 1985).

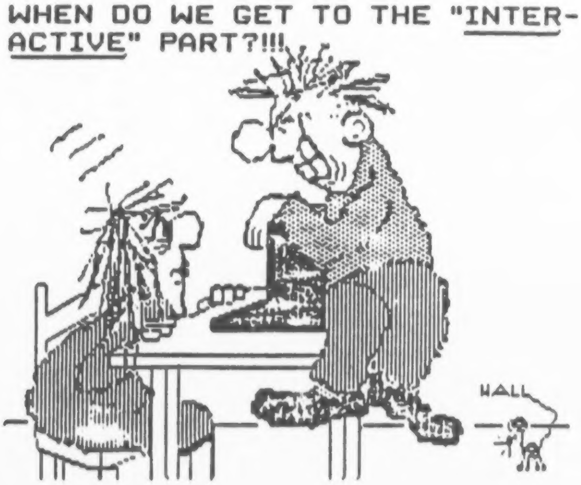
Rapid Access to Information: Trainees would no longer need to be constrained by rigid class schedules but could access Interactive-observation Learning Centers at their convenience, and consequently at their optimum learning periods. In addition, information which is not typically available in the classroom (e.g. taped demonstration) would always be available at Learning Centers.

Individualized Instruction: The flexibility of the Interactive-observation Learning Center with its individual personal response and data recording capabilities makes individualized instruction more feasible (Hart and Staples, 1980; Suppes, 1980; and Weir et al., 1982).

Endless Repetition: The computer is untiring, predictable, never angry, never bored, and controllable. Hence, each trainee is free to progress at a rate most suitable to his/her personal needs (Colby et al., 1981; Sicoli, 1982).

Increased Motivation: Most trainees have been observed to be highly enthusiastic about computer interaction and are eager and able to master its operation in just a few sessions (Chambers & Spencer, 1980; Geoffrion and Goldberg, 1981).

Increased Attention Span: The realism of television, personal interactive capabilities, easy manipulation of materials and creative programming all combine to hold the attention of the trainees (Goldenberg, 1979; Sewell et al., 1979; Bork, 1980; and Geoffrion and Goldenberg, 1981).


WHEN DO WE GET TO THE "INTERACTIVE" PART?!!!
HALL

More Immediate Feedback: Each individual trainee's data can be kept by computer, with scores from tests and drills automatically recorded and progress (Smith and Sherwood, 1976; Rushby, 1981; and Scioli, 1982). Immediate feedback is also available to the trainee as they watch the video presentation. The computer asks questions about the presentation and provides feedback relative to the correctness of the answers provided by the trainee.

Benefits to the Training Institutions:

More Efficient Inservicing: Interactive-observation will improve the attendance at school inservicing programs. Teachers may find the open availability of Learning Centers more convenient than the typical restricted schedule of the inservice lectures.

Uniformity of Information: Trainees, teaching aides and parents would have access through the Interactive-observation Learning Centers, to answer more specific questions from other trainees, and teachers, etc. who have already completed a course of study. In addition, instructors would have more time to either handle a greater number of students personally, or engage in research and program development.

Better Organization and Control of Training Information: Interactive-observation increases the flow of information in a systematic logical fashion (Fitch, 1985).

A Greater Capacity to Provide Information to Trainees and Teachers: Because an Interactive-observation Learning Center can be established for under $8,000, their availability to almost every school in the nation is assured, and because the copies of the

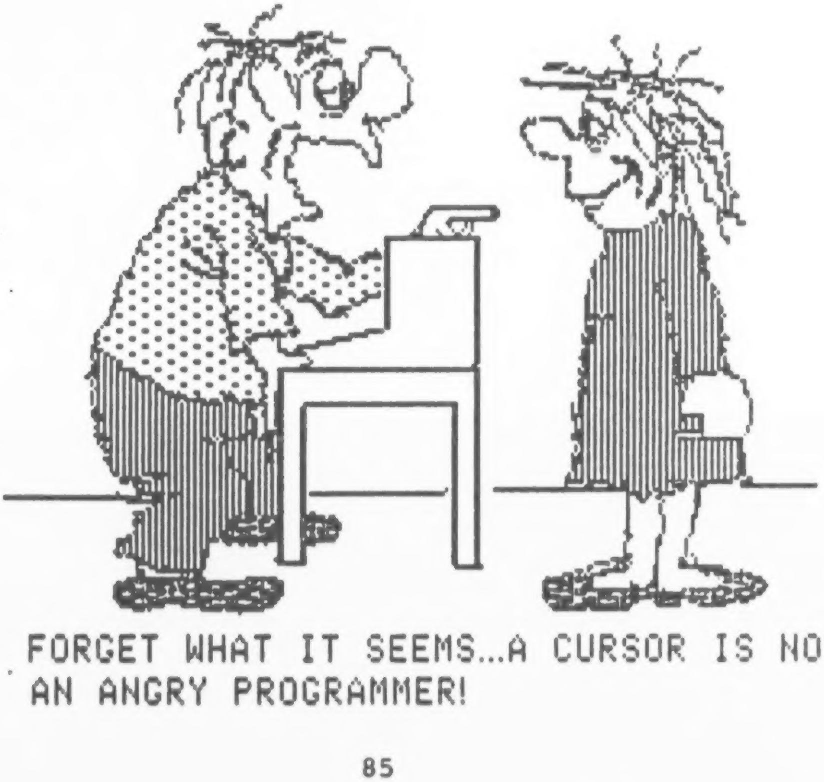
Interactive-observation modules can be obtained for under $10 in many cases, the availability of information, both general and specific to all domains of education is highly feasible.

On the following pages, there is some basic information concerning the equipment necessary to run an Interactive-observation Learning Center, including hardware and software for both the video recorder and video disc setups.

ADDRESSES

Whitney Educational Services
1777 Borel Place, Suite 416
San Mateo, California 94402
(415) 341-5818

BCD Associates, Inc
Broadway Tech Center
7510 West Broadway
Oklahoma City, Oklahoma 73116
(405) 843-4574
telex. 499-1435

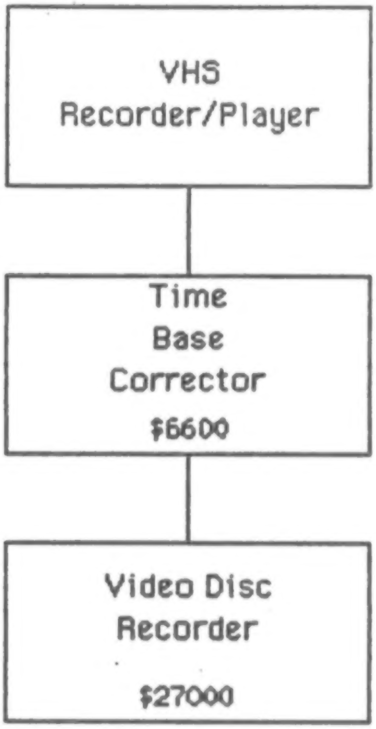


FORGET WHAT IT SEEMS...A CURSOR IS NOT AN ANGRY PROGRAMMER!

INTERACTIVE - VIDEO SOFTWARE

TAPE MANAGEMENT	
Tape Log and Management $295	--writes a number (timecode) on each frame of the videotape --permits user to utilize specific segments of the videotape according to the numbers on the timecode
LESSON DEVELOPMENT	
Superpilot Library $125	--bridges the gap between tape management control written in BASIC and the Superpilot Authoring Language written in PASCAL --copied on to the Master Authoring Disk
Superpilot Master Authoring Disk $200	--a 27 command authoring language for preparing computer assisted instruction
Superpilot Lesson Disk $2 each	--individual lessons written in Superpilot to be used by students in disc drive #1
Student Record (optional) $2 each	--optional disk used for storing student scores and other data on or from the lesson disk --used by the students in disc drive #2
Superpilot Log $50	--analyzes student data stored on the record disk or on the lesson disk

VIDEO - DISC HARDWARE



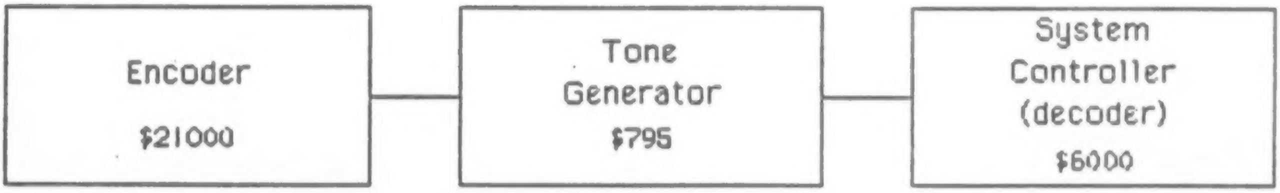
--an editing system that provides a stable timing mechanism to the audio and visual portions of the video tape for transfer to video disc

--necessary to transfer video tape to video disc

--transfers information on vidoe tape to video disc

OPTIONAL ECCO AUDIO ENCODING SYSTEM

The Audio Encoding System enables a signal to be placed on the audio portion of the video disc that will allow up to 40 seconds of audio to be played while visual frame holds for 1 still frame (1/30 second)

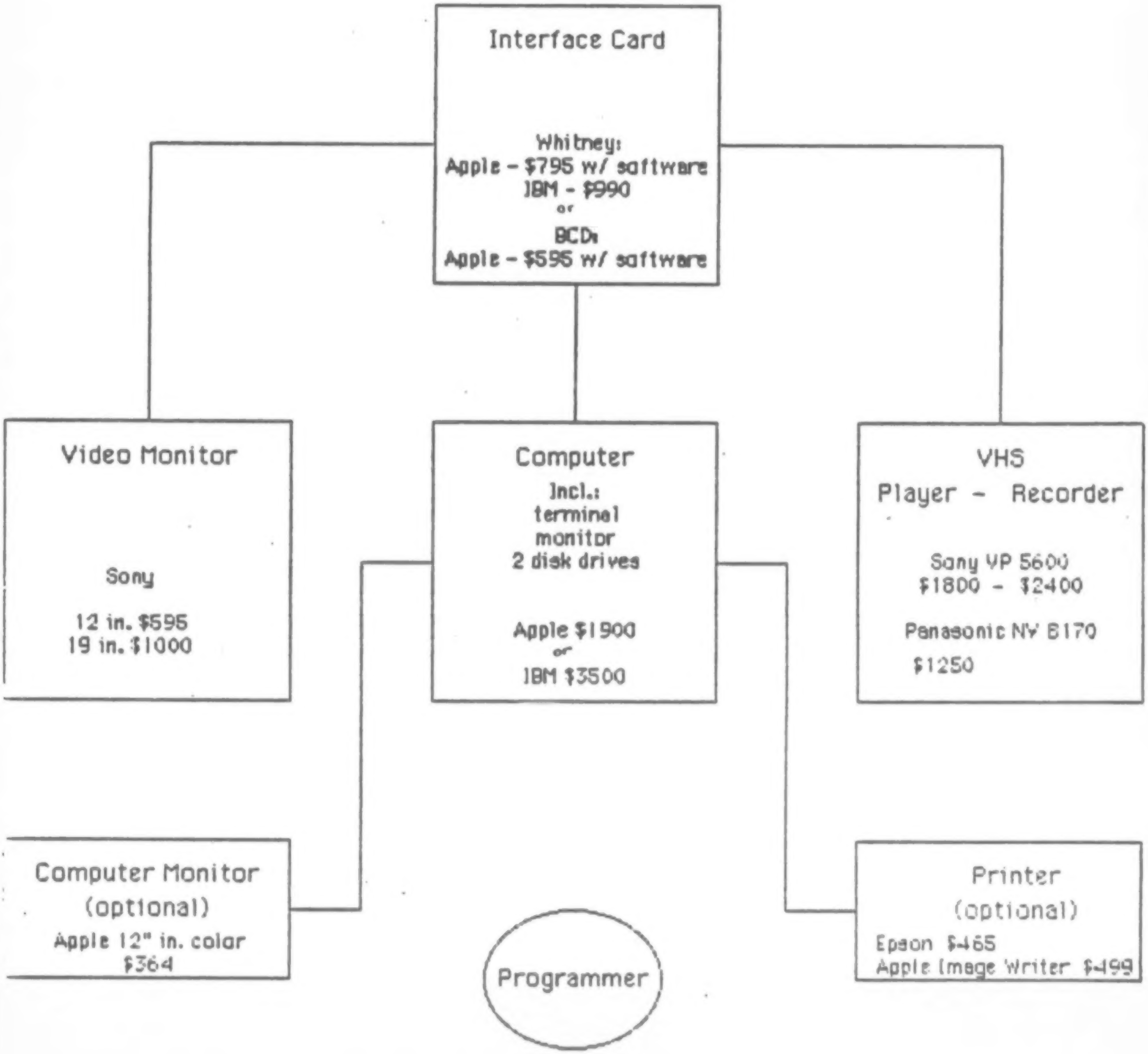


--indicates where on the video disc the signal is to be placed

--generates the tone to engage to audio portion of the video disc while holding one still frame

--decodes the tone and allows the system to move to the apropriate portion of the disc

INTERACTIVE - VIDEO HARDWARE



* Whitney A3001-A Hardware for Apple Computer:
$695 includes Interface Card and Tape/Disc Controller

** BCD Hardware for IBM Computer:
$1200 includes Interface Card and VHS
$1600 includes Interface Card and Videodisc

References

Fermejo, J.J. Computer-Assisted Instruction for Communication Disorders. *Journal for Computer Users in Speech and Hearing*, 1, 1985, 17-28.

Bork, B. Minspeak. *BYTE*, 1980, 7 (9), 186-202.

Chambers, J. and Sprecher, J. Computer-Assisted Instruction: Current Trends and Critical Issues. *Communication of the ACM*, 1980, 23 (6), 332-342.

Colby, K., Christinaz, D., Parkinson, R., Graham, S. and Karpf, D. A Word-Finding Computer Program with a Dynamic Lexical-Memory for Patients with Anomia Using an Intelligent Speech Prosthesis. *Brain and Language*, 1981, 14, 272-281.

Dillingham, L.M., Roe, J.J. and Roe, M.D. Selected Applications of Computer-Assisted Video Instruction in the Education of Hearing Impaired Students. *American Annals of the Deaf*, 1982, 27, 652-658.

Fitch, J.L. Perspective on Computers in Communicative Disorders. *Journal for Computer Users in Speech and Hearing*, 1985, 1, 15-16.

Geoffrion, L. and Goldenberg, P. Computer-Based Exploratory Learning Systems for Communication Handicapped Children. *J. of Special Education*, 1981, 15 (3).

Hart, B. and Staples, I. Microcomputers in Special Schools. *Special Education Forward Trends*, 1980, 7(4), 22-25.

Kaufman, D.M. and Kaufman, R.G. Usefulness of Videotape Instruction In an Academic Department of Neurology. *Journal of Medical Education*, 1983, 58, 474-478.

Reilly, C. Two-Way Computer Tutors. *Audio Visual Communications*, January, 1985, 30-92.

Rushby, N. Educational Innovation and Computer Based Learning. In *Selected Readings in Computer-Based Learning*, ed. by N. Rushby, Longdon: Kogan Page, 1981.

Sewell, D. Rostron A., Phillips, R. and Clark, R. Microcomputers as Aids for Assisting in the Linguistic Development of Deaf Children. *The Teacher of the Deaf*, 1979, 3(2), 36-41.

Sicoli, T. Computers and the Special Education Classroom. *BYTE*, 1982, 7(9), 270-274.

Smith, S. and Sherwood, B. Educational Uses of the PLATO Systems. *Science*, 1976, 192, 344-352.

Suppes, P. Computer-Assisted Instruction for Deaf Students. American Annals of the Deaf, 1971, 116(5), 500-508.

Thomas, W. and Thomas C. The Payoffs and Pitfalls of Video-Based Training. Training and Development Journal, 1984, 28, 28-29.

Weir, S., Russel, S. and Valente, J. LOGO: An Approach to Educating Disabled Children. BYTE, 1982, 7(9), 342-360.

# # #

DID SOMEONE CALL FOR AN EXPERT!?

Teaming The Classroom Computer With A Textbook For Teaching Phonics To Hearing-Impaired Students

Sandra Hart-Davis
Gallaudet College
Washington, DC

The acquisition of speech and language competency is often a slow process for hearing-impaired students. At Kendall Demonstration Elementary School, located on the Gallaudet College campus in Washington, D.C., a number of the 12-to 15-year-old students have speech, language and reading skills at or below the second grade level. This low level of achievement is typically accompanied by a lack of motivation to improve these skills. Experience has shown that students with these characteristics require much individual attention from the teacher if any improvements in sight vocabulary, written language or speech are to be made.

To help alleviate this problem, the classroom computer, operating with software developed by the author, was introduced into the Middle School Speech program. With this software, the computer is applied directly in support of teaching with a standard phonics textbook, Discovering Phonics We Use (Arthur W. Heilman; The Riverside Publishing Company, 1981). The computer provides both phonetic and, in conjunction with the teacher, phonologic practice tied to specific areas in the textbook.

This approach requires the student both to analyze the components of a word and to utilize the word in natural language. The student learns that words are made up of vowels and consonants, how to sound out written words as a way of pronouncing and reading, and then learns how the words are used in everyday language. The student proceeds at his/her own pace, and self-directs which activities are to be undertaken at any given time. The teacher's role is to guide and monitor, and to provide individualized instruction as needed. The role of the computer is the following:

- to provide a learning environment in which the student will become self-motivated to progress.
- to raise questions related to the material presented in the textbook.
- to drill the students in the analysis and recognition of consonants and vowel letters, their combination in words and pronunciation.
- to provide a nonthreatening and uncritical instruction/test/evaluation procedure with instant feedback to the student.
- to keep an accurate and unobtrusive score of the students progress and areas needing attention.

Synopsis

The textbook upon which the procedure is based is divided into sections which relate both to skill level and skill type. Each major section of the text is introduced by the teacher to the students in a typical classroom setting. The material is discussed in terms of the objectives and the general procedures to be followed in carrying out the text exercises.

The computer is then introduced. Text exercises, which normally would be performed by the student with pencil and paper, are performed instead using the computer. Instructions presented in the text are paraphrased and supplemented by the computer with each exercise. Since the computer-generated instructions are derived from the text and are in context, they are a valuable supplement to the teacher-generated instructions in the medium of signing/finger spelling.

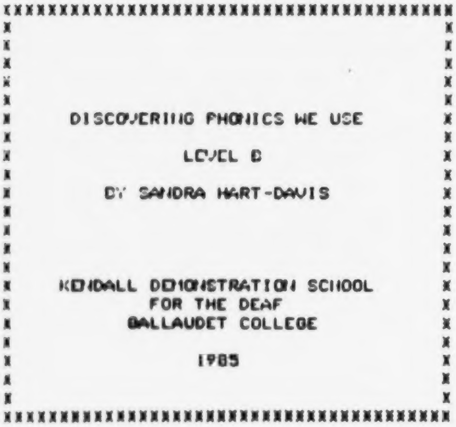
Each student proceeds through the computer-generated materials at his/her own pace. Many opportunities are provided to the student to end a session without interrupting or shutting off the computer, thereby allowing another student to begin a new session quickly. The computer exercises follow and enhance the text -- an important feature because of the disparity in the text's intended much younger age group than the age of the students.

The learning process proceeds in three phases. First, the student is exposed to words via pictures from one of the textbook pages. These words are related by initial consonants, by final consonants, by vowel sounds, etc. The teacher reinforces the sound/symbol association by articulating the words with emphasis on the component sounds. In the second phase the students are led through various exercises by the computer. These exercises, which correspond to each page in the textbook, cause the student to think about each word in terms of its structure, spelling and meaning. Auditory components of the words are emphasized by the teacher. The computer also provides an opportunity for the student to utilize each word in a sentence. The sentences provide a communication opportunity between the student and his/her peers, as well as the teacher for modifying and expanding grammar and vocabulary. In the third phase, specially designed crossword puzzles are used which are keyed to the words covered in the lesson. The puzzles are presented on the computer screen, with clues provided for each word. They may also be printed on a dot matrix printer. The student responds by entering words horizontally or vertically in the puzzle. The correct puzzle solution is provided at the end of the exercise along with the student's score. The puzzle exercises reinforce proper word spelling, contextual meaning, word association, and recall (although the student may use the textbook for reference).

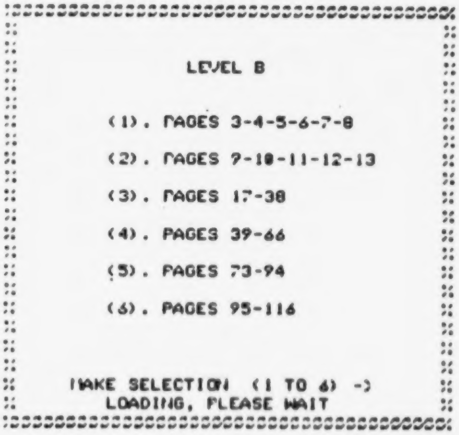
Procedure

A computer session is conducted by the student using a hierarchical set of informative displays, menus and question/response screens. The design is such as to minimize the need for teacher intervention, and to be as self-explanatory as possible. A complete set of these screens from an example session is attached at the end of this paper. The following discussion also contains some of these screens as illustrations of the procedure.

The computer software is designed to lead the student through several exercises related to each page of the textbook. No prior knowledge of computer operations is required. When the computer is turned on, it immediately displays an initial identification screen, which is shortly followed by another display identifying the text pages covered. The second display is a menu of text page groups, one of which is to be selected by the student for the session. These two screens appear as follows:



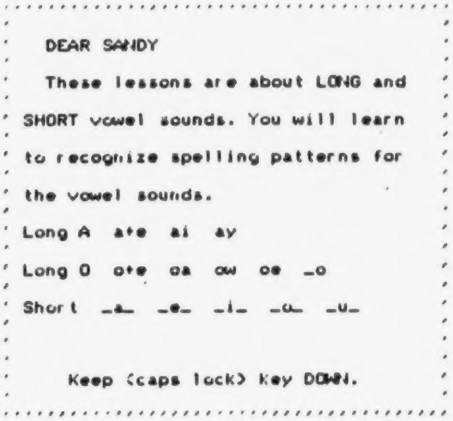
```
DISCOVERING PHONICS WE USE

LEVEL B

BY SANDRA HART-DAVIS



KENDALL DEMONSTRATION SCHOOL
FOR THE DEAF
GALLAUDET COLLEGE

1985
```



```
LEVEL B

(1). PAGES 3-4-5-6-7-8

(2). PAGES 9-10-11-12-13

(3). PAGES 17-38

(4). PAGES 39-66

(5). PAGES 73-94

(6). PAGES 95-116


MAKE SELECTION (1 TO 6) ->
LOADING, PLEASE WAIT
```

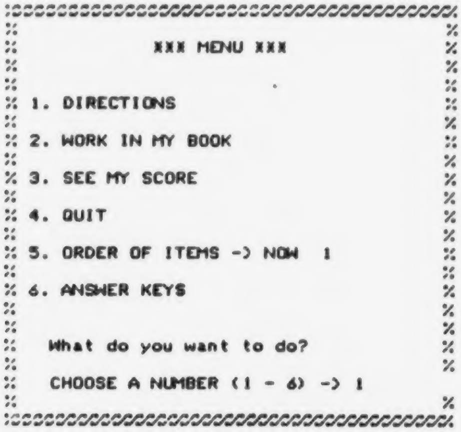
When the student selects one of the page groups, the computer requests the date and student's name to personalize subsequent activities. Another purpose of requesting information from the student is to initiate the beginning of a dialog between the student and the computer via the displays and keyboard. The asking of simple questions of this type helps overcome the initial intimidation felt by first time users as well as offering a nonthreatening hands-on experience with the computer. The students name is repeated to the student from time to time by the computer to emphasize a "user friendly" and personal environment.

After entering his/her name and date, the student is presented with a brief introduction to the objectives of the exercises to come. This introduction is tailored to the specific material presented in the textbook, and, again, is intended to encourage the development of an interactive relationship between the student and the computer. The teacher reads the screen with the student and explains any words or concepts that the student does not understand. An example of this screen is shown below.

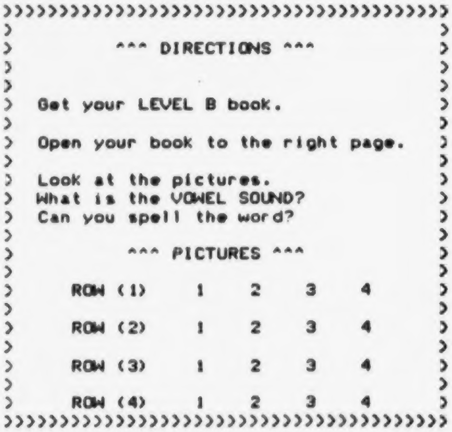


```
  DEAR SANDY
  These lessons are about LONG and
SHORT vowel sounds. You will learn
to recognize spelling patterns for
the vowel sounds.
Long A  a+e  ai  ay
Long O  o+e  oa  ow  oe  _o
Short  _a_  _e_  _i_  _o_  _u_


    Keep <caps lock> key DOWN.
```

Next, the computer displays the main menu of options which may be performed. This menu may require some initial explanation by the teacher before the student can fully understand the options presented. The first option, "directions," provides a display of instructions for the uninitiated student. The second option, "work in my book," is selected by a student who is ready to proceed with the exercises pertaining to a specific page in the textbook. The third option, "see my score," displays the student's score from the exercises. The forth option, "quit," ends the session. The fifth option, "order of items," allows the teacher or student to cause the computer to select questions during the exercises in a repetitive sequence (the default choice if Option 5 is not selected) or randomly. The sixth option, 6, "answer keys," provides the correct spelling of all of the vocabulary used in each exercise. This option provides opportunities for auditory training, e.g., <u>find the word</u>, speech reading, sight word vocabulary, sign language practice, and speech drills. The menu and the display of directions resulting from the selection of Option 1 are shown below.

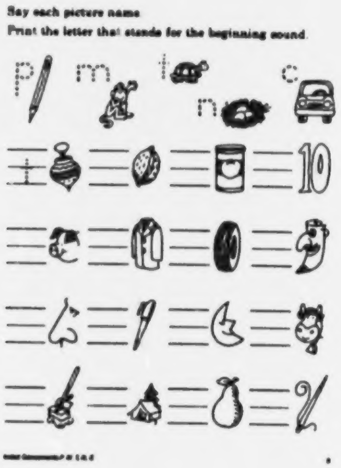


```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                      %
%             XXX MENU XXX             %
%                                      %
%                                      %
% 1. DIRECTIONS                        %
%                                      %
% 2. WORK IN MY BOOK                   %
%                                      %
% 3. SEE MY SCORE                      %
%                                      %
% 4. QUIT                              %
%                                      %
% 5. ORDER OF ITEMS -> NOW  1          %
%                                      %
% 6. ANSWER KEYS                       %
%                                      %
%                                      %
%   What do you want to do?            %
%                                      %
%   CHOOSE A NUMBER (1 - 6) -> 1
%                                      %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

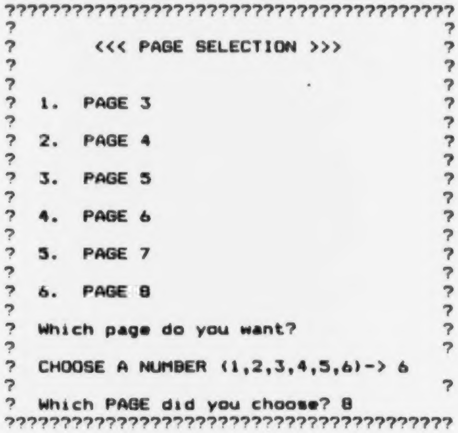


```
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>                                      >
>           ^^^ DIRECTIONS ^^^         >
>                                      >
>                                      >
>  Get your LEVEL B book.              >
>                                      >
>  Open your book to the right page.   >
>                                      >
>  Look at the pictures.               >
>  What is the VOWEL SOUND?            >
>  Can you spell the word?             >
>                                      >
>            ^^^ PICTURES ^^^          >
>                                      >
>      ROW (1)    1    2    3    4     >
>                                      >
>      ROW (2)    1    2    3    4     >
>                                      >
>      ROW (3)    1    2    3    4     >
>                                      >
>      ROW (4)    1    2    3    4     >
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

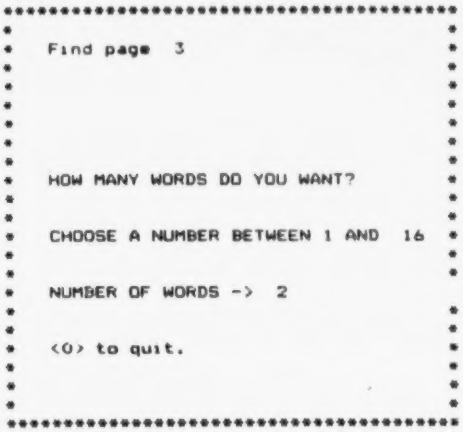
The "picture key" displayed in the directions refers to the text page layout. A copy of an actual textbook page is shown below. As may be seen in this copy, the actual textbook page contains four rows containing four pictures per row. This coding of pictures by row and column position is used throughout the exercises.


Say each picture name
Print the letter that stands for the beginning sound.

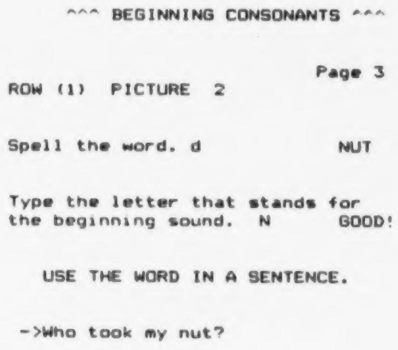
The menu display reappears after the directions screen. If the student were then to choose option 2, "work in my book," a display of specific page options to choose would then appear. This display allows the student to select the exact page in the textbook in which to work. The display is shown below.


```
????????????????????????????????????????
?                                      ?
?       <<< PAGE SELECTION >>>         ?
?                                      ?
?                                      ?
?  1.   PAGE 3                         ?
?                                      ?
?  2.   PAGE 4                         ?
?                                      ?
?  3.   PAGE 5                         ?
?                                      ?
?  4.   PAGE 6                         ?
?                                      ?
?  5.   PAGE 7                         ?
?                                      ?
?  6.   PAGE 8                         ?
?                                      ?
?  Which page do you want?             ?
?                                      ?
?  CHOOSE A NUMBER (1,2,3,4,5,6)-> 6
?                                      ?
?  Which PAGE did you choose? 8
????????????????????????????????????????
```

After selecting the textbook page, the student is then presented with the choice of how many of the words illustrated on the chosen page are to be included in this particular exercise. In the following illustration, the student has selected two words on page 3 of the textbook. The computer then responds with the question/response screen shown below.



```
****************************************
*                                      *
*  Find page  3                        *
*                                      *
*                                      *
*                                      *
*                                      *
*                                      *
*                                      *
*  HOW MANY WORDS DO YOU WANT?         *
*                                      *
*                                      *
*  CHOOSE A NUMBER BETWEEN 1 AND  16   *
*                                      *
*                                      *
*  NUMBER OF WORDS ->  2               *
*                                      *
*                                      *
*  <0> to quit.                        *
*                                      *
*                                      *
*                                      *
****************************************
```

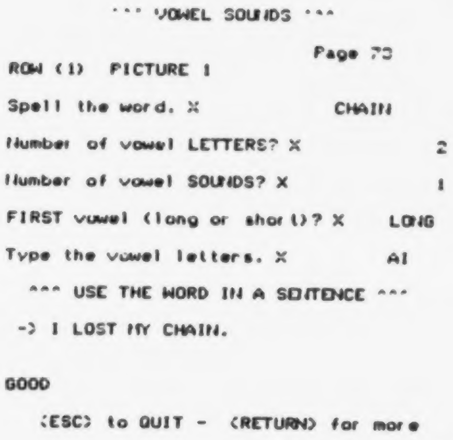


```
           ^^^ BEGINNING CONSONANTS ^^^

                                     Page 3
ROW (1)  PICTURE  2

Spell the word. d               NUT

Type the letter that stands for
the beginning sound.  N       GOOD!

   USE THE WORD IN A SENTENCE.

 ->Who took my nut?
```

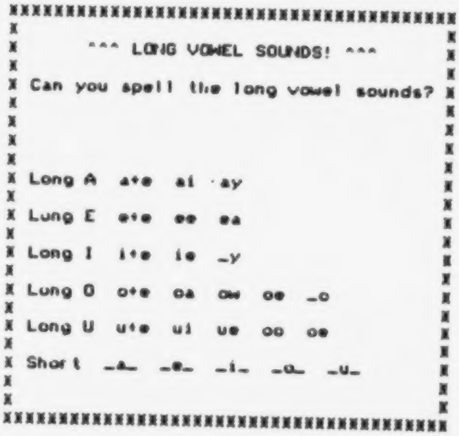
The student examines, in this example, the second picture in row one on page 3 of the textbook [Row (1) Picture (2)], and decides how to spell the word. The spelling of the word is entered on the keyboard, and the computer verifies the entry. If the spelling is incorrect ("d" instead of "nut" in the example), the computer responds with the correct spelling before continuing. If the spelling is correct, the computer responds with "good." The computer then asks for the letter representing the beginning sound. In this simple example the beginning sound is represented by a single letter ("N"), but in later, higher level exercises the sound may require more than one letter.

If the student's answers up to this point are correct, the computers with "good!" and asks the student to enter a sentence containing the word. The sentence response area has three lines of space for keyboard entry. This space may be used for writing sentences, presenting speech drills by the teacher, spelling practice by the student, or any other text entry activity.

The above example and discussion apply to a very basic level exercise, in this case beginning consonants. As the student progresses, the exercises grow in sophistication as shown below, in the case of vowel sounds. In this instance the computer has asked for the number of vowel letters in the word presented by the picture in the textbook. The correct response given, the computer then requests the number of vowel sounds in the word, and, for the first vowel, whether it is long or short. As in the first example, the student is then asked to use the word in a sentence.

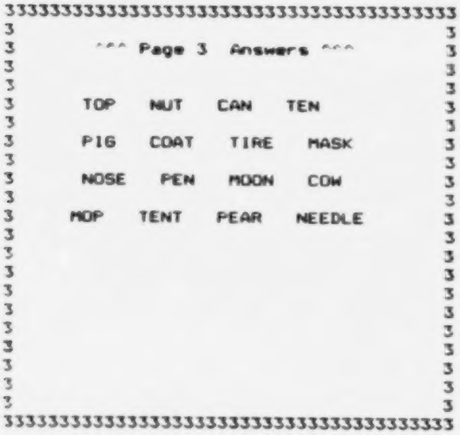


```
          ^^^ VOWEL SOUNDS ^^^
                                  Page 73
ROW (1)  PICTURE 1

Spell the word. X                  CHAIN

Number of vowel LETTERS? X               2

Number of vowel SOUNDS? X                1

FIRST vowel (long or short)? X     LONG

Type the vowel letters. X          AI

  ^^^ USE THE WORD IN A SENTENCE ^^^

 -> I LOST MY CHAIN.

GOOD

   <ESC> to QUIT -  <RETURN> for more
```

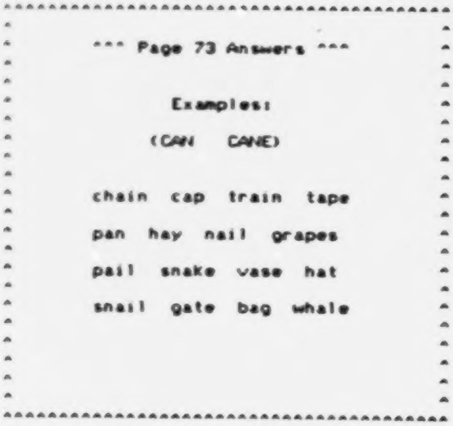


```
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X                                        X
X      ^^^ LONG VOWEL SOUNDS! ^^^        X
X                                        X
X Can you spell the long vowel sounds?   X
X                                        X
X                                        X
X                                        X
X                                        X
X Long A  a+e  ai  ay                    X
X                                        X
X Long E  e+e  ee  ea                    X
X                                        X
X Long I  i+e  ie  _y                    X
X                                        X
X Long O  o+e  oa  ow  oe  _o            X
X                                        X
X Long U  u+e  ui  ue  oo  oe            X
X                                        X
X Short  _a_  _e_  _i_  _o_  _u_         X
X                                        X
X                                        X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

At this point the student may end the exercise and return to the main menu, or continue with another exercise. If the student elects to end the exercise, he/she may then choose to review the answers to the questions posed in the exercises. An example answer key displayed by the computer is shown below. This answer key indicates the correct spelling for each of the pictures found on the chosen page in the textbook.

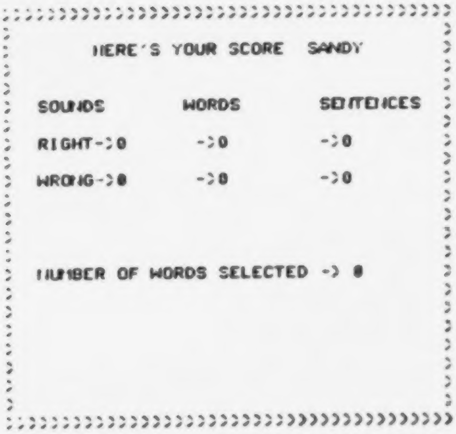


```
^^^ Page 3  Answers ^^^

TOP    NUT    CAN    TEN

PIG    COAT   TIRE   MASK

NOSE   PEN    MOON   COW

MOP    TENT   PEAR   NEEDLE
```

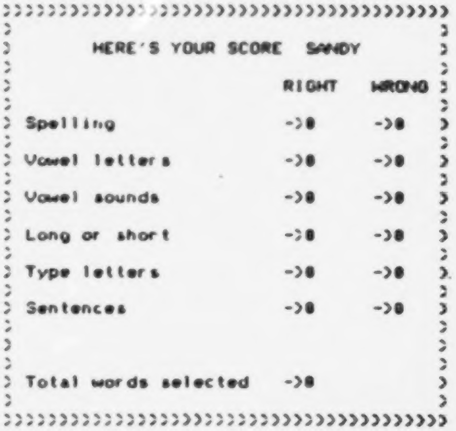


```
^^^ Page 73 Answers ^^^

Examples:

(CAN   CANE)

chain  cap  train  tape

pan  hay  nail  grapes

pail  snake  vase  hat

snail  gate  bag  whale
```

The student may also review his/her score. An example display of the cumulative score for the session is the following.

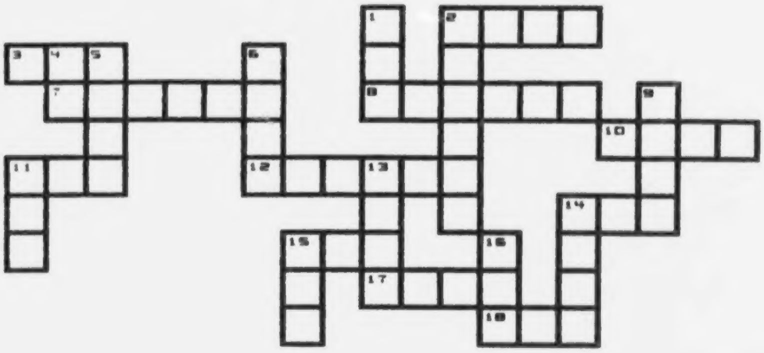


```
HERE'S YOUR SCORE  SANDY

SOUNDS       WORDS       SENTENCES

RIGHT->0      ->0         ->0

WRONG->0      ->0         ->0



NUMBER OF WORDS SELECTED -> 0
```



```
HERE'S YOUR SCORE  SANDY

                          RIGHT   WRONG

Spelling                   ->0     ->0

Vowel letters              ->0     ->0

Vowel sounds               ->0     ->0

Long or short              ->0     ->0

Type letters               ->0     ->0

Sentences                  ->0     ->0



Total words selected       ->0
```

Additional language enhancement is provided by means of computer-generated crossword puzzle exercises. These exercises continue with the words and relationships covered in the previous question/response exercises. A puzzle is organized to challenge the student to recall words from the earlier exercises, using clues provided with the puzzle. A blank puzzle is presented on the computer screen with the clues at the bottom, as shown below. The student fills in the puzzle on the screen using the keyboard, and then the computer validates this input.



ACROSS CLUES

2. Something you wear at Halloween.
3. A kind of toy.
7. Something to sew with.
8. Something to write with.
10. Part of your face.
11. Something to drive.
12. An animal with a hard shell.
14. I bought a ___ of tomatoes.
15. Something to write with.
17. Part of a car.
18. Squirrels like to eat me.

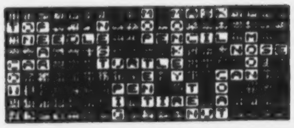
DOWN CLUES

1. Something to clean the floor.
2. An animal that likes to eat bananas.
4. The answer is ON.
5. A fruit. Something to eat.
6. A bird lives in a ___.
9. It shines at night.
11. An animal. It says,"Moo".
13. Something to sleep inside of. I slept in a ___ at camp.
14. Clothing. Something to wear when it is cold.
15. An animal. It says,"oink".
16. A number. 1,2,3, _ _ _ _ _ _ _.

WORD LIST: B PAGE 3

CAR
CAN
COW
COAT
MASK
MOP
MONKEY
MOON
NEEDLE
NEST
NOSE
NUT
ON
PENCIL
PEN
PEAR
PIG
TENT
TEN
TIRE
TOP
TURTLE

ANSWERS: B PAGE 3



Results

The results of applying the computer in this way have been very rewarding. Benefits of this approach include increased student interest in the task at hand, a faster learning pace and better retention of the material by the students, peer support in performing exercises correctly, and positive social interaction. Other benefits include a marked improvement in teacher productivity and, as a by-product, the exposure of the students to computers and keyboard interaction.

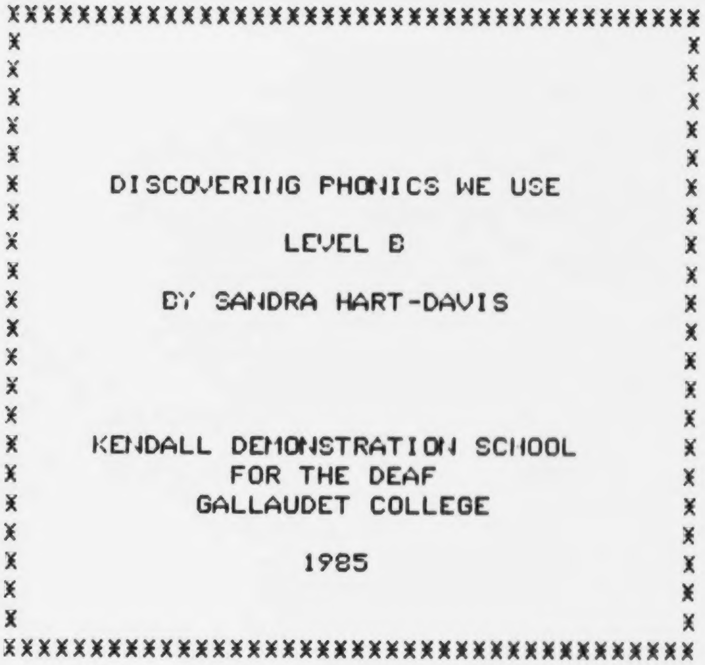
Discussion

"Phonics" is the application of phonetics to the teaching of reading. Using the phonics approach means to use the sounds made in speech and the pronunciation of words and syllables as part of the teaching of the meaning and use of words. This is the approach of the computer application described above. Pictures are used to represent words in the textbook. A word is analyzed from the point of view of vowels and consonants, and correct spelling. It is then "sounded out" based upon its components. The next step is the utilization of the word in a signed or verbal sentence. Finally, practice is provided in the use and spelling of the word via crossword puzzle games.

Teaching with phonics is important for hearing-impaired students. Hearing students have the advantage of hearing words in everyday speech which, together with reading, augments the understanding of word usage and increases vocabulary. Without this advantage, hearing-impaired students are limited to the visual impression of word symbols. Phonics, as applied through the computer application described above, is multi-sensory in its approach. Students verbalize the words. They visualize the words through pictures of the words in the textbook, and the printed form on the computer screen. They associate the symbols and the sounds of the words. And they involve their motor skills as they type the letters of the word in response to the computer queries. This variety of learning modes significantly enhances the students interest, holds and maintains his/her attention, and increases the motivation to learn.

Teaming The Classroom Computer With A Textbook For Teaching Phonics To Hearing-Impaired Students

APPENDIX



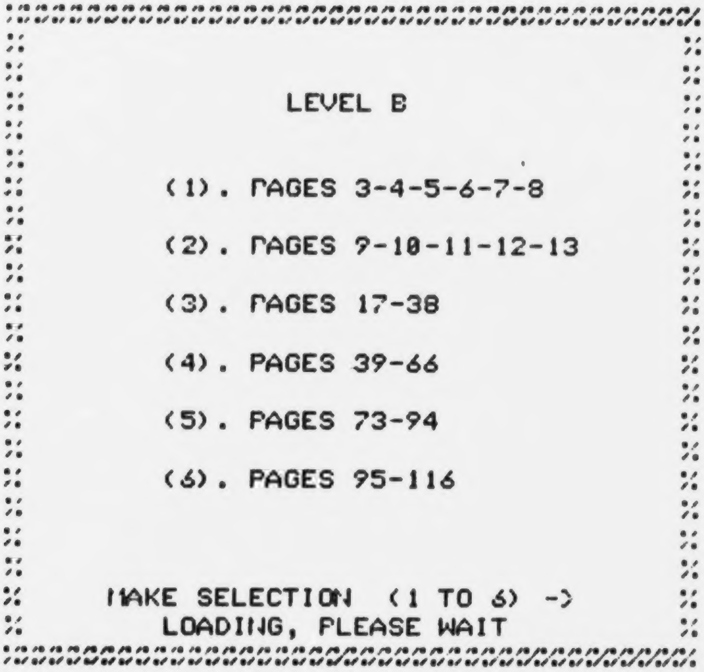
DISCOVERING PHONICS WE USE

LEVEL B

BY SANDRA HART-DAVIS

KENDALL DEMONSTRATION SCHOOL
FOR THE DEAF
GALLAUDET COLLEGE

1985



LEVEL B

(1). PAGES 3-4-5-6-7-8

(2). PAGES 9-10-11-12-13

(3). PAGES 17-38

(4). PAGES 39-66

(5). PAGES 73-94

(6). PAGES 95-116

MAKE SELECTION (1 TO 6) ->
LOADING, PLEASE WAIT

LEVEL B

DISCOVERING PHONICS WE USE

(Pages 3,4,5,6,7,8)

DEVELOPED BY SANDRA HART-DAVIS

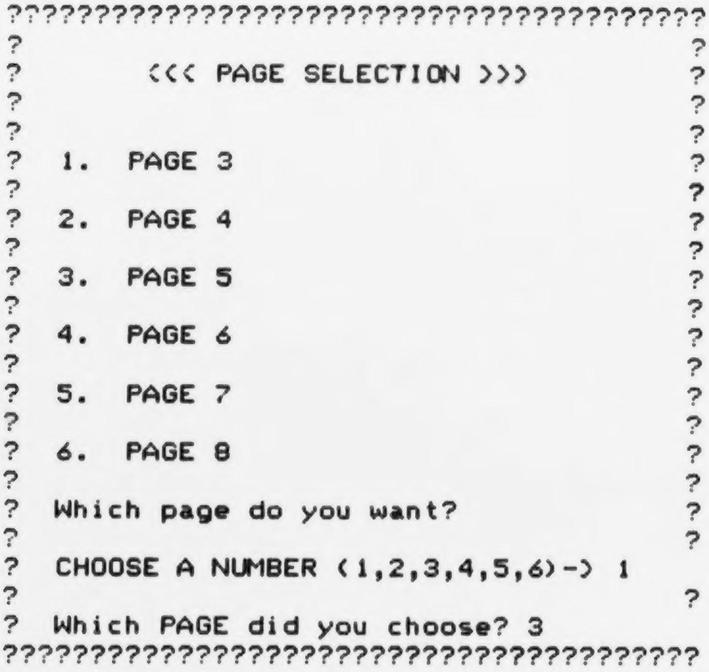
@ D & H ASSOCIATES

```
########################################
#                                      #
#                                      #
#                       10/17/85       #
#                                      #
#                                      #
#   DEAR  SANDY                        #
#                                      #
#   These lessons are about beginning  #
#                                      #
#   consonants.  You will learn about  #
#                                      #
#   the SOUNDS--pmtcn,blkdf,sgrhw,and  #
#                                      #
#   vzjqu. All those letters are       #
#                                      #
#   called CONSONANTS.                 #
#                                      #
#                                      #
#                                      #
#          XXX HAVE FUN! XXX           #
#                                      #
########################################
```

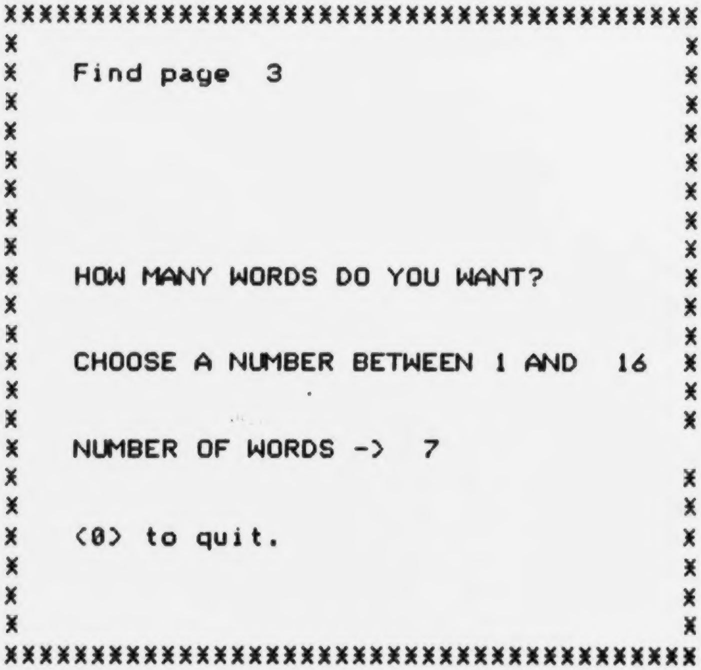
```
::::::::::::::::::::::::::::::::::::::::
:                                      :
:             XXX MENU XXX             :
:                                      :
: 1. DIRECTIONS                        :
:                                      :
: 2. WORK IN MY BOOK                   :
:                                      :
: 3. SEE MY SCORE                      :
:                                      :
: 4. QUIT                              :
:                                      :
: 5. ORDER OF ITEMS -> NOW             :
:                                      :
: 6. ANSWER KEYS                       :
:                                      :
:                                      :
:   What do you want to do?            :
:                                      :
:   CHOOSE A NUMBER (1 - 6) -> 3
:                                      :
::::::::::::::::::::::::::::::::::::::::
```

```
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>                                     >
>       HERE'S YOUR SCORE  SANDY      >
>                                     >
>                         RIGHT  WRONG >
>                                     >
> Spelling                ->0    ->0  >
>                                     >
> Vowel letters           ->0    ->0  >
>                                     >
> Vowel sounds            ->0    ->0  >
>                                     >
> Long or short           ->0    ->0  >
>                                     >
> Type letters            ->0    ->0  >
>                                     >
> Sentences               ->0    ->0  >
>                                     >
>                                     >
>                                     >
> Total words selected    ->0         >
>                                     >
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```

```
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>                                     >
>         ^^^ DIRECTIONS ^^^          >
>                                     >
>                                     >
>  Get your LEVEL B book.             >
>                                     >
>  Open your book to the right page.  >
>                                     >
>  Look at the pictures.              >
>  What is the beginning sound?       >
>  Can you spell the word?            >
>                                     >
>          ^^^ PICTURES ^^^           >
>                                     >
>     ROW (1)    1    2    3    4     >
>                                     >
>     ROW (2)    1    2    3    4     >
>                                     >
>     ROW (3)    1    2    3    4     >
>                                     >
>     ROW (4)    1    2    3    4     >
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
```



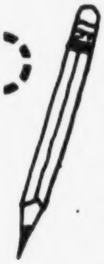
```
????????????????????????????????????????
?                                      ?
?       <<< PAGE SELECTION >>>         ?
?                                      ?
?                                      ?
?  1.   PAGE 3                         ?
?                                      ?
?  2.   PAGE 4                         ?
?                                      ?
?  3.   PAGE 5                         ?
?                                      ?
?  4.   PAGE 6                         ?
?                                      ?
?  5.   PAGE 7                         ?
?                                      ?
?  6.   PAGE 8                         ?
?                                      ?
?  Which page do you want?             ?
?                                      ?
?  CHOOSE A NUMBER (1,2,3,4,5,6)-> 1
?                                      ?
?  Which PAGE did you choose? 3
????????????????????????????????????????
```



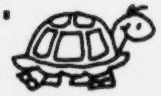
```
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X                                      X
X   Find page  3                       X
X                                      X
X                                      X
X                                      X
X                                      X
X                                      X
X                                      X
X   HOW MANY WORDS DO YOU WANT?        X
X                                      X
X                                      X
X   CHOOSE A NUMBER BETWEEN 1 AND  16  X
X                                      X
X                                      X
X   NUMBER OF WORDS ->  7
X                                      X
X                                      X
X   <0> to quit.                       X
X                                      X
X                                      X
X                                      X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Say each picture name.

Print the letter that stands for the beginning sound.

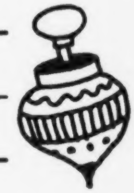
p


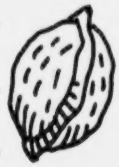
m

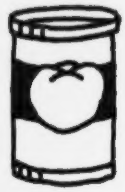
t


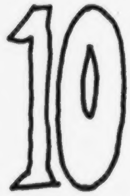
n

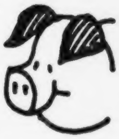
c

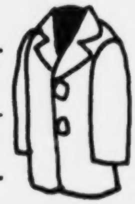
t


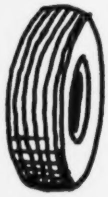
______


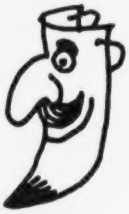
______


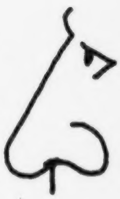
______


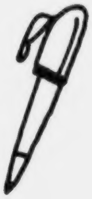
______


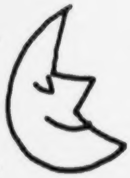
______


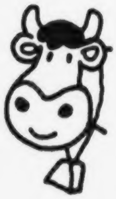
______


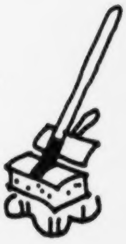
______


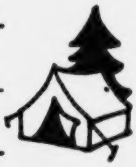
______


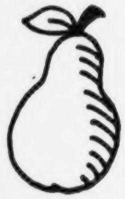
______


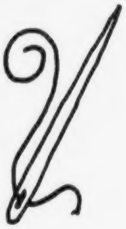
______


______


______


______


______


______


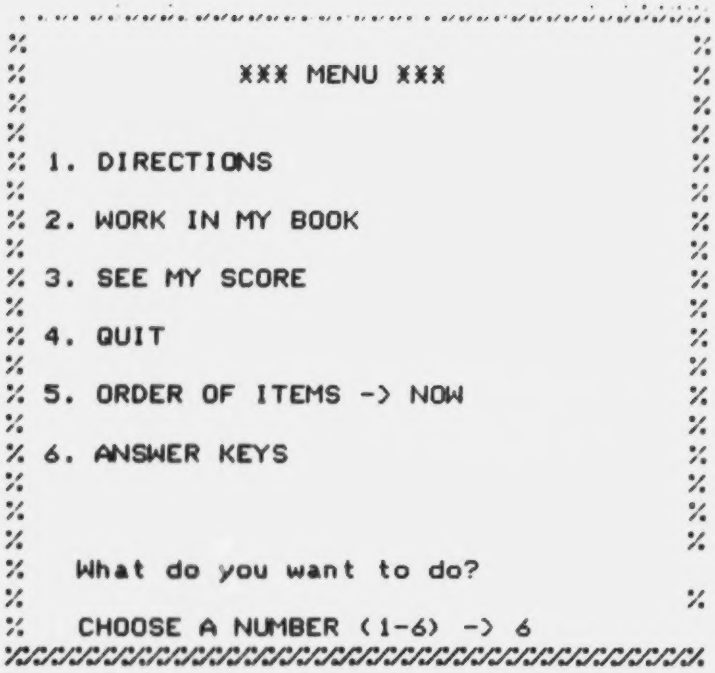
Initial Consonants *P, M, T, N, C*

```
     ^^^ BEGINNING CONSONANTS ^^^

                           Page 3
ROW (1)  PICTURE 1


Spell the word. TOP          GOOD!


Type the letter that stands for
the beginning sound.  T      GOOD!


   USE THE WORD IN A SENTENCE.


 ->MY TOP IS NEW.

GOOD
 Press <ESC> to QUIT - <RETURN> for more
```

```
     ^^^ BEGINNING CONSONANTS ^^^

                           Page 3
ROW (1)  PICTURE  2


Spell the word. X            NUT


Type the letter that stands for
the beginning sound.  X      N


   USE THE WORD IN A SENTENCE.


 ->WHO ATE THE NUT?

GOOD
 Press <ESC> to QUIT - <RETURN> for more
```

```
3333333333333333333333333333333333333333
3                                      3
3       ^^^ Page 3  Answers ^^^        3
3                                      3
3                                      3
3      TOP   NUT   CAN   TEN           3
3                                      3
3      PIG   COAT   TIRE   MASK        3
3                                      3
3      NOSE   PEN   MOON   COW         3
3                                      3
3     MOP   TENT   PEAR   NEEDLE       3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3                                      3
3333333333333333333333333333333333333333
```

```
----------------------------------------
-                                      -
-     ^^^ SELECTION OF ITEMS ^^^       -
-                                      -
-                                      -
-   DO YOU WANT THE QUESTIONS:         -
-                                      -
-                                      -
-   IN ORDER (1,2,3,etc.) -> CHOOSE 0  -
-                                      -
-                                      -
-   MIXED UP (4,1,10,etc.) -> CHOOSE 1 -
-                                      -
-                                      -
-   SELECT A NUMBER -> 0 or 1 1
-                                      -
-                                      -
-                                      -
-   Items will be mixed up!            -
-   CURRENTLY SET AT  1                -
-                                      -
-                                      -
----------------------------------------
```



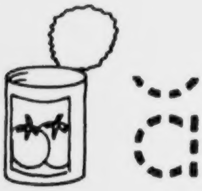
```
%                                       %
%               *** MENU ***            %
%                                       %
%                                       %
% 1. DIRECTIONS                         %
%                                       %
% 2. WORK IN MY BOOK                    %
%                                       %
% 3. SEE MY SCORE                       %
%                                       %
% 4. QUIT                               %
%                                       %
% 5. ORDER OF ITEMS -> NOW              %
%                                       %
% 6. ANSWER KEYS                        %
%                                       %
%                                       %
%                                       %
%   What do you want to do?
%                                       %
%   CHOOSE A NUMBER (1-6) -> 6
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

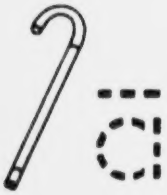
```
      ^^^ Page Selection ^^^

1.73        8.80        15.87       22.94

2.74        9.81        16.88

3.75       10.82        17.89

4.76       11.83        18.90

5.77       12.84        19.91

6.78       13.85        20.92

7.79       14.86        21.93

 WHICH PAGE DID YOU CHOOSE? 73

 CHOOSE A NUMBER (1 - 22) -> 1
```

```
****************************************
*                                      *
*   Find page  73                      *
*                                      *
*                                      *
*                                      *
*                                      *
*                                      *
*                                      *
*   HOW MANY WORDS DO YOU WANT?        *
*                                      *
*                                      *
*   CHOOSE A NUMBER BETWEEN 1 AND  16  *
*                                      *
*                                      *
*   NUMBER OF WORDS ->  9
*                                      *
*                                      *
*   <0> TO QUIT.                       *
*                                      *
*                                      *
*                                      *
****************************************
```

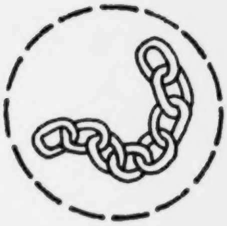
```
       ^^^ VOWEL SOUNDS ^^^

                             Page 73
ROW (1)  PICTURE 1

Spell the word. X            CHAIN

Number of vowel LETTERS? X             2

Number of vowel SOUNDS? X              1

FIRST vowel (long or short)? X    LONG

Type the vowel letters. X         AI

  ^^^ USE THE WORD IN A SENTENCE ^^^

 -> I LOST MY CHAIN.


GOOD

   <ESC> to QUIT -  <RETURN> for more

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X                                     X
X      ^^^ LONG VOWEL SOUNDS! ^^^     X
X                                     X
X Can you spell the long vowel sounds? X
X                                     X
X                                     X
X                                     X
X                                     X
X Long A  a+e  ai  ay                 X
X                                     X
X Long E  e+e  ee  ea                 X
X                                     X
X Long I  i+e  ie  _y                 X
X                                     X
X Long O  o+e  oa  ow  oe  _o         X
X                                     X
X Long U  u+e  ui  ue  oo  oe         X
X                                     X
X Short  _a_  _e_  _i_  _o_  _u_      X
X                                     X
X                                     X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

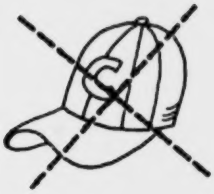
Say each picture name.
Listen for the vowel sound.
Trace ă or ā to show
the sound you hear.

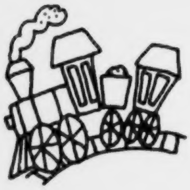


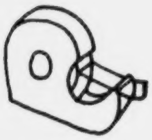


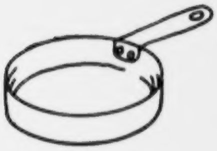
Circle the pictures whose names have the ā sound.
Put an X on the pictures whose names have the ă sound.

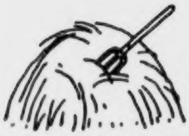


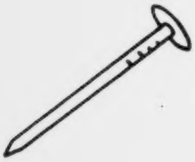


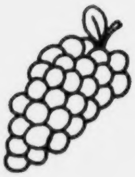


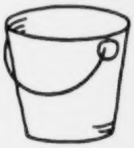


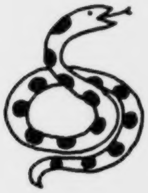


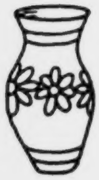


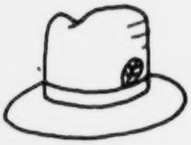


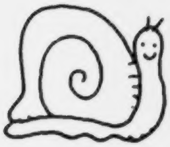


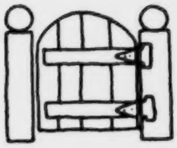


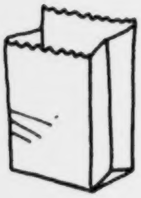


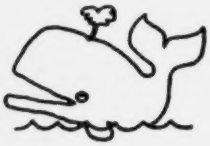




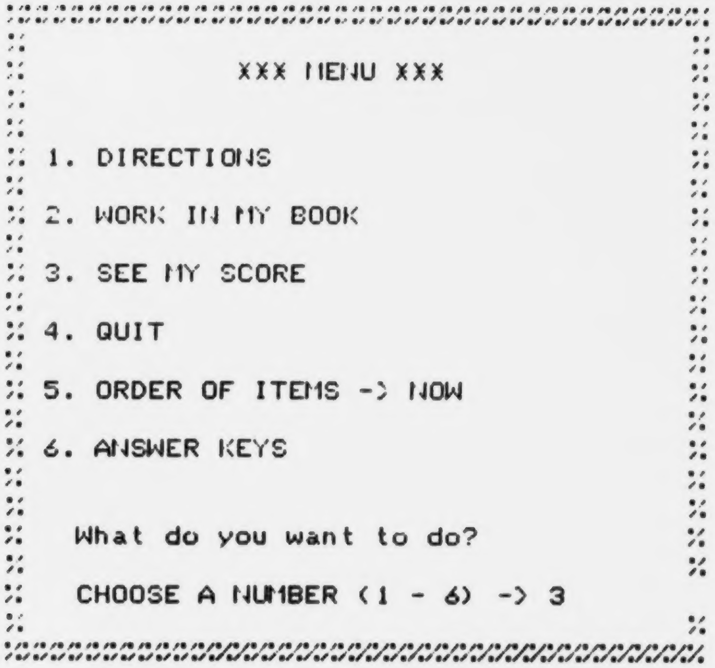




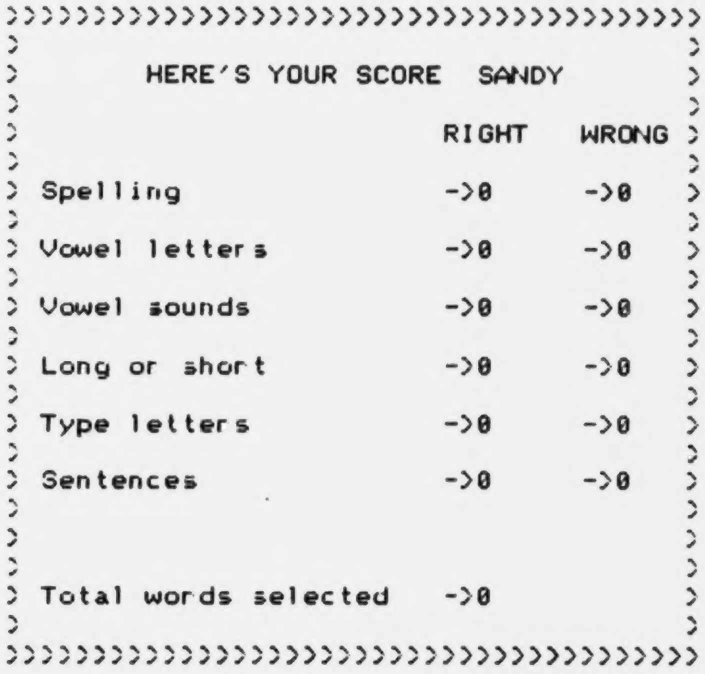




Auditory Discrimination: Short and Long *A*



```
              XXX MENU XXX

 1. DIRECTIONS

 2. WORK IN MY BOOK

 3. SEE MY SCORE

 4. QUIT

 5. ORDER OF ITEMS -> NOW

 6. ANSWER KEYS


   What do you want to do?

   CHOOSE A NUMBER (1 - 6) -> 3
```



```
        HERE'S YOUR SCORE  SANDY

                            RIGHT   WRONG

 Spelling                   ->0     ->0

 Vowel letters              ->0     ->0

 Vowel sounds               ->0     ->0

 Long or short              ->0     ->0

 Type letters               ->0     ->0

 Sentences                  ->0     ->0



 Total words selected       ->0
```

Alternate Access Methods For Users Of Computer-Based Information Systems

David L. Jaffe
Palo Alto Veterans Administration Medical Center
Palo Alto, CA

Need

The rehabilitation community with its numerous members, their varied professions and abilities, and geographic dispersion, has many special problems. For example, without continued interaction, organizations and individuals can become isolated from the rest of the community. As a result, rehabilitation research activities and funding are often duplicated, new techniques and devices are not widely disseminated, many experiences of members are not communicated, and potential users of aids may not have a voice in device development.

Computer-based information systems such as NARIC and ABLEDATA have been developed to promote community interaction by addressing users' needs for bibliographic and product-oriented information. Although these systems provide data that are potential sources of solutions, their primary means of access requires personal possession of computer or CRT terminal and modem equipment, knowledge of their use, and expertise with each system's specific command language. The lack of such devices and skills are major barriers preventing the widespread and effective use of these and other on-line information exchange mechanisms.

Problem

Despite the overwhelming need to communicate rehabilitation concerns and solutions, there is currently no universal means to access a forum where such issues can be discussed. Although electronic information systems that remove geographic and schedule barriers to interaction are in operation, they have limitations. Some only allow information retrieval from a large database and are ineffective in the dissemination of users' requests or experienced-based information to other members of the rehabilitation community. Other systems are inaccessible or inappropriate for those with disabilities. In addition, a high level of proficiency attainable only with considerable training and practice is often required before full advantage can be made of these resources.

Solution

The ideal solution to the information exchange problem is a mechanism that enables rehabilitation community members to make informed decisions based upon an enhanced ability to interact. If a system existed that would allow easy access to its information, the barriers that distance, time, finances, ability, and possession of equipment impose would be reduced, permitting wider participation.

Significance

Several improvements in the rehabilitation process could result from the employment of new methods which increase user interaction with computer-based information systems. For example, the elimination of the requirement for a modem and CRT terminal would result in a greater subscribership to those on-line systems. Portions of the rehabilitation community that have been excluded from this type of participation due to the burden of acquiring this equipment, the inappropriateness of the display, and/or the effort in learning its operation would then be able to engage in information exchange despite their varying abilities, lack of traditional computer communication equipment, and/or training.

This easier access to computer-based information services could provide a wealth of opportunities to members of the rehabilitation community. Information on devices, job opportunities, travel, and resources could all be more easily obtained if user-appropriate electronic interfaces were available. A system that requires no special equipment for access (other than a telephone), provides interaction between users, is easy to learn and use, and is equally suited for all those interested in rehabilitation issues would provide a significant improvement in information dissemination and informed decision-making.

Hypothesis

It is hypothesized that computer-based systems whose information is accessible by a variety of methods can be used by the rehabilitation community to foster increased information exchange and consumer involvement. In particular, telephone accessible on-line computers that employ alternate interfaces would reduce the barriers that presently prevent easy interaction. These new means of retrieving and reporting rehabilitation information could be incorporated into both existing and future system implementations permitting more members of the rehabilitation community to participate in meaningful information exchange.

Approach

This project seeks to evaluate alternate methods of access to computer-based information systems. Two classes of interfaces will be addressed, that between the user and the computer system -- the user interface and the one between the user and the data -- the system interface.

If access to the central information system were modified to accept, in addition to CRT terminal and modem inputs, voice recognition and Touch-Tone inputs and produce synthesized speech or coded Touch-Tone outputs, then these translated user inputs and system outputs would convey the wishes of the user and communicate computer responses in much the same fashion as the customary equipment. Then the possession of, and familiarity with, a standard telephone would be all that would be required. In this manner, those without a CRT terminal and modem could participate in information exchange as well.

One possible access technique translates information destined for hearing-impaired individuals into Touch-Tones. The Echo 2000.[1] Talk-Tone,[2] or Teltone T-100[3] telecommunication devices are portable units designed to decode Touch-Tone signals sent by another user or computer system into displayed letters and numbers. In a similar manner, telephone users could send requests to the remote computer system using the same encoding scheme.

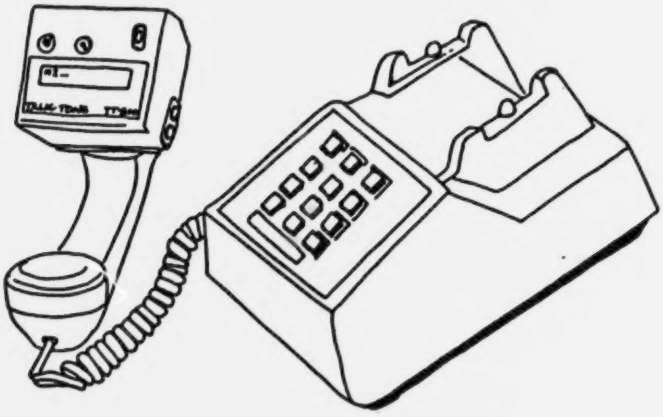


Figure. The Talk-Tone telecommunications device that decodes Touch-Tones and displays alphanumeric information.

The other requirement for successful communication with a remote system is the need to make one's request understandable to that system. Currently, each system has its own unique operating language which one must learn. Acquiring this electronic syntax is often difficult because of the multitude of commands and their structure (usually abbreviations), and requires some insight into the workings of the remote system. Since computer technology is responsible for this situation, it might also offer a solution. For example, a software agent can serve as a translator of users' wishes into system commands. This personalized electronic "tour guide" could assist the user in finding solutions by querying the computer in its own language while responding with a intelligible synthetic voice.

Access schemes drawn from familiar games would also make the retrieval of information easier. For example, the familiar game of Twenty Questions could serve as a model for the interaction between the agent and the user. The agent would "ask" the user a series of yes/no questions; the user would respond by voice or by pressing the appropriate button on the Touch-Tone telephone. The recognition of the vocal responses or decoding of the button-press would give the agent some knowledge of the information the user desires. The agent could then formulate commands in the syntax of the host on-line system to retrieve the requested information. In this example, responses to the twenty questions would select one out of a million items.

Query scenarios based upon television game shows (Let's Make A Deal), computer games (Adventure), and board games (Trivial Pursuit) could be modified for friendly information retrieval purposes. Complex computer command syntax could be replaced by these familiar interactions. In a modified Adventure game, instead of searching for treasure, the user/player would search for rehabilitation information using a mechanism that is both familiar and interesting.

Other interaction possibilities include the manipulation of simulated persons. In this case, the user would be able to select tasks to be performed by these imaginary electronic characters. Observation of the actions of these "people" as they act out various rehabilitation scenarios could foster information exchange. The user could direct a paraplegic agent/actor to purchase a new wheelchair, participate in therapy, look for housing, or seek a job. This electronic "soap opera" could provide insight into issues and possible solutions to rehabilitation problems for both individuals with disabilities and health care professionals. A dialog between several simulated characters is also possible given the multi-voice personality of advanced speech synthesizers such ad DECtalk.[4]

This project's goal is to design and evaluate alternate methods of access to computer-based information systems. Speech synthesis, Touch-Tone signalling, and speech recognition strategies will be researched as substitutes for the traditional CRT terminal and modem. Several friendly data retrieval schemes will be developed and studied as well. The use of schemes judged to be inexpensive, appropriate, easy to learn, friendly to operate, interesting to use, and efficient in information retrieval could lead to enhanced information exchange that would benefit all those concerned with rehabilitation issues.

Current State of Effort

Several user interfaces have been examined. A DECtalk speech synthesizer has been donated and its ability to produce highly intelligible speech has been investigated. Its capability to answer the telephone, speak selected computer text files, and decode user-generated Touch-Tones has been demonstrated with a microcomputer system. Touch-Tone signalling for the benefit of hearing-impaired individuals has also been accomplished. A simple system interface has been implemented with which a user can request and hear abstracts of current projects being undertaken at this Center.

Summary

New and effective ways of exchanging information among members of the rehabilitation community can be identified by evaluating alternate access methods to computer-based information systems. Subsequent implementation of these schemes would improve the quality and quantity of these interactions. A greater subscribership in the information exchange process would result from the elimination of the requirement of a CRT terminal and modem equipment. Portions of the rehabilitation community that have been excluded from participation due to the burden of acquiring this equipment, the inappropriateness of the display, and/or the effort in learning its use would then be able to engage in information exchange despite their varying abilities, lack of traditional computer communication equipment, and/or training. Access to, and use of such an enhanced information system would permit its many users to make educated decisions on issues that affect their work, purchases, prescriptions, and achievement of life's goals.

Acknowledgements

Veterans Administration, Jib Ray, Digital Equipment Corporation, Digital Research Incorporated, Palmetto Technologies, Inc., Audiotone, Teltone.

References

[1] Echo 2000, Palmetto Technologies, Inc., P.O. Box 498, Duncan, SC 29334.

[2] Talk-Tone, Audiotone, P.O. Box 2905, Phoenix, AZ 85062.

[3] T-100, Teltone, Kirkland, WA.

[4] DECtalk, Digital Equipment Corporation, Maynard, MA 01754.

# # #

Integrating Computer Technology With Severely Handicapped And Learning Handicapped Students

Richard Kleitman, George Haskell, and Toby Dowling
Office of Merced County Superintendent of Schools
Merced, CA

This presentation demonstrates computer application for two populations of handicapped students in Merced County California. The Office of Merced County Superintendent of Schools (OMCSS) operates four coordinated special education programs. Schelby School for the Severely Handicapped, Sierra Schools for the Severely Emotionally Disturbed, Early Childhood Special Education and Education for the Communicatively Handicapped. Each o f these coordinated programs has recently written and received a grant of AB 803 funding from the State Department of Education to improve computer education programs.

Each of these coordinated programs is based on the philosophy described in the OMCSS Computer Usage Plan.

> " Computer Technology represents the most sophisticated set of tools yet developed. In the hands of competent trained teachers, computers can address the full spectrum of learning styles and can bridge communication deficits through the use of speech synthesis and word processing.
>
> As a result of utilizing these sophisticated tools, students will be able to function more independently and effectively in the community.
>
> We believe that appropriate use of computer technologies is a feasible means by which we can develop the full potential of our students."

The purpose of the paper is to describe and review the efficacy of utilizing computer instruction with the severely handicapped students at Schelby School, with the severely emotionally handicapped students at Sierra School and with the county learning handicapped at

Planada School.

Severely Developmentally Delayed Students

The first coordinated program to be discussed in this presentation serves developmentally delayed (with a minimum delay of two years) students at Schelby School who are being taught the rudimentary skills necessary to interact with a computer.

Computer technology is so extremely sophisticated, no person can be an expert in the use of all computers, no matter how gifted or delayed they may be. With this realization in mind, any computer education program must limit the vast number of possible subject areas to the most vital component for productive computer use. The program objective for the developmentally delayed student does just that. It trains the student to operate software as independently as possible.

This objective was selected because most commercially available software requires reading, comprehension and cognitive skills well above the developmentally delayed student's level to operate. Yet, the subject matter of the software is often appropriate for the student's needs. The student is often able to operate these programs with minimal assistance and supervision after some basic instruction with simpler software designed to train specific computer operation techniques, i.e., keyboarding a desired response. Inputting an answer using any key, the space bar or return key, identifying an onscreen prompt to select or operate a program or input an answer. Many errors can be avoided by simplifying (ignoring repetitive prompts) or adapting the input/output phase of the computing process. A list of essential skills including strategy and software used to instruct these skills accompanies this paper.

The instructional phase of the computer program has demonstrated the need for one on one supervision in the introduction of each software option taught to the individual student. The frustration experienced by the student when seemingly no action taken achieves the desired response is often devastating. The helping hand of an instructor eliminates simple errors which do not pertain to the subject of the lesson, but rather to the operation of the computer.

Teacher inservice time is a vital component for student success. Teachers need time to master the operation of each program they will be instructing. Extra attention needs to be focused on learning and correct response sequence for each on screen prompt and making as many errors as possible to master the correction routines within that program More sophisticated programs have different modes which require different responses such as the write or correct mode, main menu mode and transfer menu mode of the Bank Street Writer word processor. Each mode reacts differently to the same inputs. This type of confusion is eliminated when the teacher spends enough time mastering the software before attempting to have a student use it.

Another important step in the instructional process is the use of practice or experimental "on line" time for each student. It is necessary to observe the student's first independent use of a software option to insure that the reinforcement routine of the software is functionally effective.

Several of the students have found the correction routine of the software more reinforcing than the reinforcement routine. Teacher attention remains the highest motivator to most students and attention to correct responses and teacher approval in seeing the reinforcement cycle of a software option are usually enough to help the student strive to make correct responses.

Although the first step of the instructional process stresses computer operation rather than correctness of responses, the teacher must begin to shift the instruction back to reinforcement of correctness. Again, the teacher should observe the student's utilization of software options to find the most challenging program which the student will be successful in operating. Some programs lend themselves to this very well by utilizing a "difficulty level counter" which increases the difficulty of problems presented for each correct answer the student inputs. Another important feature of software which will increase the student's ability to operate challenging programs is a good correction routine. Software that simply requests a user to try again contributes to a cycle of frustration. Software which visually demonstrates an algorithm for solving the problem or showing the answer clearly, maintains student interest and often helps to increase skills and competences with the subject matter.

An equally important step in the instructional process is the realization of both staff and student growth. The utilization of time to investigate new software options and develop new programs is the investment which will keep computers interesting and exciting to our teachers and students. Computer usage has a wonderful side effect for the developmentally delayed student since the world at large perceives those who use the computer as smart. This perception is a rewarding reason to keep our students involved and enthused about trying to use computers.

Severely Emotionally Disturbed and Learning Handicapped Students

The students enrolled in Sierra School represent a student population with a grade level between kindergarden and twelfth grade. The students from the learning handicapped class are third to eighth grades. Students in these programs usually have very significant academic deficits in the area of language arts. The Sierra Students tend to be one to two years behind in their academic achievement in the area of language arts. The learning handicapped students lag three to four years behind their grade level.

Each of the four sites received at least fur Apple Computers to achieve a 3:1 student to computer ratio. The school sites also received at least one printer, one color monitor, a speech synthesizer and a joy stick. The teachers and administrator selected Language Arts software.

Inservice training was provided as an ongoing event. Teachers were provided with a variety of types of inservice. Dr. Dave Uslan, from the California State Department of Education Clearing house Depository for Handicapped Students, was contacted to provide teachers with exposure to new hardware and the variety of things computers can do in the classroom. The school employed an individual with technical expertise to show teachers some of the basic components of the computers system and also to familiarize them with common procedures and commands used in operating software. Further, inservice opportunities are planned as teachers grow more familiar with the machine and how they will be used in the classes.

Teachers decided which student would learn to touch type and who would hunt and peck depending on the child's coordination and physical size as well as in the typing program.

Our school utilizes the Bank Street word processor; the student is encouraged to use it right away. At first, they used it involving multiple choice and single answers. As they grew more proficient with typing, they were able to complete longer language related assignments. For example, they could complete parts of their spelling assignments such as writing words ten times each or doing sentences for spelling words. Finally, they were able to produce creative writing assignments.

Students were taught to use the features on the Bank Street writer sequentially to permit utilization of the program as rapidly as possible.

1. Enter and edit text
2. Save text on a disk
3. Retrieve text on disk
4. Print text using standard format

The Save and Retrieve functions were very similar procedures. Students were shown how to reach these items on the menu and how to answer correctly the questions asked of them. Actually, many also received prior exposure to these items since they were able to watch the teacher save materials and listen to explanations of how to do it. Students who caught on quickly were also quite wiling to help others.

The teaching staff didn't always have time to guide each student through the procedures.

The majority of students have a desire to use the computer. Of course, some do not have the skills to utilize a program like the Bank Street Writer. There are options for them. Very simple word processors exist. At present, we are exploring the use of programs with our most limited students. Typically, these programs allow the student to type in words on the screen, make corrections and print out the finished product using very few key strokes.

Results

Our program started only a few months ago and we are all still growing. As such, there is little in the way to concentrate data to present at this time except for reports from teacher and students.

Using the word processor, the quality of writing in our classrooms has improved in several ways. Students are producing finished assignments with fewer errors in a shorter time. This is because they can simply edit in text rather than recopying an entire paper. Obviously, the typed papers are neater than handwritten ones. Our students also produce longer assignments.

Finally, the work is more creative. The students seem willing to spend more time putting in colorful adjectives and details to flesh out their stories.

The personal benefit for the students is impressive. Being able to use and control the computers makes them feel successful and intelligent. They feel more confident when they participate in the writing process. They are even willing to start writing letters for their own purposes and that is point of any good writing program.

Integrating Computer Technology with Severely Handicapped and Learning Handicapped Students

The program objective for the developmentally delayed students is to train them to operate software as independently as possible. The subject matter of many software options is appropriate for these students but operating the computer requires reading, comprehension and cognitive skills far beyond their capabilities.

The instructional process begins with the teacher mastering the operation of each software option they teach. Then, the student is introduced to the program with one-to-one supervision guidance and assistance. The emphasis is on making the software function rather than knowing the correct answer. At this level teachers read all prompts for the student and often input responses for them. Next, the student extends their operation of the machine one step at a time. Students may only touch random keys on the keyboard at first but each step is trained until they are inputting their own answers. The teacher then observes to be sure the programs built in reinforcement cycle is reinforcing to the child and that they are able to answer some of the questions correctly. After being observed, the student refines his skills further by utilizing more commands within the program or learning another program.

The following is a list of important skills, useful strategies and software options used to instruct students in basic computer operation. They are listed in the following format:

Skill Strategy Software

Keyboard Interaction: Utilizes brightly colored sound displays that reinforce any touch of the keyboard.

"Colors touch keyboard," "Keyboard star train," PROTRACOA, Stickybear series, XEROX

Muppet Learning Keys (stage one), KOALA, provides an alternative input device for mastering this skill

Keyboard interaction with a single desired key: The space bar and return key are the most commonly used for inputting data.

"Colors teach return key," PROTRACOA, "Body Recognition," LEARNING WELL

Inputting a single key stroke response: Limit the number of possible mistakes by masking unnecessary portions of keyboard. Use software with exciting computer reinforcement for correct responses.

"Match a Letterl," "Match a Numberl," PROTRACOA, "Alphabet Song Count," EDUSOFT

Utilizing the escape key to end a program or get help prompt: Teach students to try this technique if the computer repeats a question they don't understand.

All of the previously mentioned, PROTRACOA programs have this feature.

Muppet Learning Key

touchtablet has two similar keys, "ZAP" & "HELP."

Waiting for the appropriate prompt before responding: Several programs do not clear the keyboard buffer before each input is read. This leads to extra "return" signals and many wrong answers before a student masters the software operation. Teaching this skill requires one on one over the shoulder attention and shouting "WAIT" a lot. One way to teach this skill is to demonstrate the operating pattern or order for each software option, whether it is input-return-return, or wait for computer to highlight correct answer space bar.

"Keyboard Startrain," PROTRACOA,

"Body Recognition," LEARNING WELL

Utilizing the return key to input an answer: Stress the pattern of input-return, input-return. Do not correct an incorrect input selection. Simply reinforce any appropriate input-return sequences.

"Super Word Printer," PROTRACOA

Inputting responses without holding the key down and repeating characters: Requires mastery of two previous skills inputting single keystroke responses and utilizing the return key to input an answer. If a student is successful in a program requiring only a single keystroke response switching to the same or similar program requiring a multistroke response works well.

"Match a Letter2," "Match a Number2," PROTRACOA

Remembering the s top or escape sequence of a program: This is a problem for many software designs. As each is different they must be taught differently. Have student read or listen to all of the set up questions and prompts in a program, even if the instructor is entering responses which are beyond the students keyboarding, reading or spelling ability.

"Count Star," "Rocket Star Count," "Doing Match Calculations," PROTRACOA. The last one, "Doing math calculations," has a built in reminder of how to exit the program which quickly becomes tiresome to advanced users and demonstrates the value of memorizing the escape routine.

Selecting a program or subroutine using a menu: Early in the instructional cycle this is often done by the instructor for the student. But when the instructor reads the prompts out loud and encourages the student to input their own responses to the teachers verbal prompt the concept is very easily learned.

"S.C.O.U.T. disk," PROTRACOA, Apple Presents Apple, APPLE II DISKWARE, Body Recognition, LEARNING WELL, MECC Preschool Disk #7.

# # #

Miss STIM: An Extra-Interactive Electronic Learning System

Curt Knoppel, Betty Fried, and James H. Bargelt
ITX Labs
North Hollywood, CA

Introduction

Educating the severely handicapped presents special challenges due to the student's reduced capacity to learn. With severe handicaps, such as autism, this task is compounded by both the presence of behavioral disorders and the need to begin the educational process on a very basic level. Recently, the use of computers in the classroom has helped increase the learning capacity for the handicapped population by repetitively presenting educational material, identifying and evaluating trends in the student's responses, and by remaining immune from fluctuations in emotional behavior.

Miss STIM (from stimulation) is an electronic teaching aid designed, by ITX Laboratories, Ltd., with the intention of increasing the computer's educational potential through the integration of commercially available technology. The electronic hardware has been assembled to provide Miss STIM with a "humanoid " personality. On the front of Miss STIM (Figure 1), two color monitors serve as the eyes while the lens of a hidden video camera serves as the nose. On the rear panel, there are two video disk players, a standard video cassette recorder, a computer keyboard, and a monitor for the teacher. Like a teacher, Miss STIM is highly mobile and can easily be moved throughout the classroom.

Miss STIM presents educational material called Stimware. The Stimware possesses both high resolution video images and audio signals on two laser videodiscs and is programmed to present lesson material in conjunction with the responses from the student. Further, Stimware offers versatility not found in other forms of instruction. The uses of this interactive videodisc technology create exciting new possibilities for handicapped children that will be described in greater detail later.

System Operations

The hardware components for Miss STIM can be divided into four separate areas: stimulus generators, student response recorders, video monitors, and computerized control devices. A block diagram illustrating the relationships between these components is shown in Figure 2.

Prerecorded audio and video tutorials are stored on plastic laserdiscs and presented to the student using two videodisc players. After the signals travel through a specially designed electronic interface, they are presented to the student on two separate color monitors. Audio signals are presented using two loud speakers. The student watches the tutorial and responds by pressing keys on a specially designed keypad. Responses from the keypad are sent to a computer where their accuracy is evaluated and stored for later analysis. The instructor controls Miss STIM using a standard computer keyboard and a small monitor located on the rear panel. She can change the lesson tutorial by responding to a few simple instructions from the computer or store and print data using two disk drives and a dot matrix printer.

One advantage of Miss STIM is the full integration of sophisticated consumer technology. Miss STIM uses two interactive, computer controlled, videodisc players (Phillips VP 935). These devices store video images on a plastic disc (as opposed to the magnetic tape used with video cassette recorders). During operations, a low powered laser is directed against the disc and retrieves the previously recorded audio and video images. Since the mechanical arm that contains the laser never actually comes in contact with the disc, the videodisc player is able to jump to different locations on the disc without encountering any mechanical interference (a complete sweep across the disc takes less than two seconds. The videodisc players used with Miss STIM can, by simply providing the computer with a few commands, scan forward, scan in reverse, jump to any section on the disc, advance through the lesson at an accelerated or decelerated pace, or freeze a single frame on the screen.

Three color monitors (Panasonic CT-1111D) are used with Miss STIM (two students, and one control monitor). Each monitor presents high resolution images from either the computer or videodisc player and feature easily accessible tint, contrast, brightness, and color controls. Using two monitors with the student provides Miss STIM with unique teaching capabilities. In one mode, two sets of video images can be presented on different monitors. One monitor could, for example, present a lesson tutorial while the second provides a visual reward for correct responses. In a second mode, a set of images from the videodisc player can be shown on one monitor while the child's own image, via the video camera and video cassette recorder, is seen on the second monitor. This feature is useful when the child is required to mimic specific physical actions that occur while learning sign language or speech/articulation training. The teacher's monitor is highly versatile and can be used to either view the program being presented, view the child via the video camera, or access the computer menus to control the lesson.

As stated earlier, the student's physical responses are recorded and stored on video tape to provide the instructor with the option of watching how the child reacts when presented with certain types of stimuli. A Magnavox (model VR2877BK) video camera is connected to a Magnavox (model VQLS903) video cassette recorder. The camera features a 35mm zoom lens, electronic viewfinder, and a built in omnidirectional condenser microphone. The video cassette recorder contains all of the standard features including tape advance, rewind, pause, and single frame viewing.

The unique nature of these instruments is how they are controlled by Miss STIM. During normal operation, while the student is responding, Miss STIM records the video information and time-codes the tape so the instructor can quickly locate and evaluate specific images. For example, if the instructor notices that a student consistently fails on a small number of stimuli, she can quickly review the child's behaviors by locating those recorded images which correspond to the specific set of responses. Further, the operations of the camera and video recorder are controlled by the computer.

The front panel of Miss STIM contains connecting ports for a keypad (or, when appropriate, a keyboard) that will be used by the student when responding. Keypads can be detached from Miss STIM and placed on a table in front of the student. Numerous keypad configurations are currently being developed by ITX Laboratories ranging from boards with four or five large multicolored buttons to a full scale computer keypad for typing text and numerical information. In the future, the keypads will light up the correct button when the student responds appropriately and provide vibrotactile feedback.

Two of the central components for Miss STIM's operations involve the computer and interface. Miss STIM's currently uses a Commodore 64 (C64) computer with 64 kilobytes of available storage space. The teacher's keyboard is the actual computer keys on the C64. During normal operation, the computer receives information from the student, via the student's keypad, and determines the accuracy of the response. This response is stored in memory while the computer instructs the videodisc players to present new information (or reintroduce the same information in a different manner).

The interface box serves as a switching network for all of the electronic components. It relays images from the videodisc players to the appropriate monitors and allows the instructor to immediately access any single piece of equipment and determine its operational status. Further, it contains a modem for telecommunication, a device for stamping the date and time onto the videotape, and the speech sampler to store and insert the student's name into the program at the appropriate moment. Later versions of Miss STIM will use a speech synthesizer to generate both the child's name and the audio signals within the program.

Three different computer peripherals are available with Miss STIM. Two INDUS GT disk drives are used to store individual student data on standard 5.25 inch floppy disks. The memory capacity for each disk is 166 kilobytes. An optional letter quality or dot matrix printer will be available for Miss STIM to provide hard copies of the student's responses for later reference.

Tutorial StimwareTM

A second integral component of Miss STIM is the Stimware. Stimware provides Miss STIM with the ability to present highly sophisticated educational material using the audio/visual signals stored on laser videodiscs. Specifically, the Stimware components provide Miss STIM with a simple personality and allow her to come "alive."

Stimware components are comprised of four separate disks (two video discs and two computer floppy disks). The computer disks contain programs which perform three distinct functions: (1) The coordination of different electronic components throughout the Miss STIM system, (2) the control of audio/video images from the video disc players to the two monitors, and (3) data storage for individual student files following the completion of a lesson.

Each of these three processes is complex. The instructor controls the videodisc players, monitors, video camera, and video cassette player using a simple menu-driven software program (Appendix 1). During this procedure, the instructor begins by selecting an item from the main menu which contains general system commands (eg. beginning a lesson, viewing a student file). Later, a command from a sub-menu allows the instructor to perform specific operations (ie. viewing the lesson in an accelerated mode). The process of controlling the software program has been simplified and typically involves pressing only one number on a computer keypad. If a problem within the Miss STIM system, or the instructor needs additional information about a specific command, then a friendly "Help" menu can be accessed by pressing one key.

The second process involves having the computer engage in the intricate switching of audio/visual images between the two student monitors, along with the recording of the student's physical actions via the video camera and cassette recorder. Each Stimware tutorial involves the use of numerous audio and video segments. Since these tutorials are responsive to the student's actions, a computer program was designed to control the flow of information. In each tutorial, a series of commands specifies which section of the lesson will be presented, the order of presentation, how the audio and video images will be combined, and whether the child's name will be inserted into the sentence(s).

The third function involves storing a student's responses following the presentation of a lesson. Miss STIM provides each student with an individual storage disk. The storage disk can be embedded with the student's name, a student code number, and a password which prevents unwanted access. During the tutorial, Miss STIM automatically records the correct and incorrect responses. After the lesson is terminated, these responses are transferred on to the student's floppy disk along with the date, time, and lesson number. Later, when the instructor is interested in evaluating the student's performance, Miss STIM searches through the files and calculates the results for each lesson (or series of lessons).

The use of laserdisc technology provides Miss STIM with extraordinary versatility. A total of 54,000 video frames can be stored on one side of each disc. This storage capacity represents a total of one hour of material (assuming that the program runs in a linear progression). However, unlike other educational methods, an interactive videodisc player does not need to operate in this mode. Instead, the videodisc players can search back through the tutorial to present same segments repeatedly to the student. Two separate segments can even be combined to form a completely new set of stimuli. In fact, the 54,000 frames can be combined to create an almost infinite number of stimulus combinations.

Other forms of technology lack this versatility. For example, if 200 frames are used to present a single concept to a student, and the concept needs to be repeated (which is common for handicapped students), the random access memory (RAM) capabilities used in interactive video technology enables the videodisc player to return to the beginning of the segment and repeat the same stimulus. Video cassette programs or film strips, require the storage of multiple sets of needless images on tape to perform this same operation. This occupies more space on the tape and increases the cost of designing the program.

Numerous Stimware programs are in the process of being designed for Miss STIM (Appendix 2). Each lesson is intended to present a comprehensive program in one major area that is impaired in communication/learning handicapped children. Other areas of application include employment training and medical rehabilitation. Already, educators are using (Slaton, 1985) laserdisc technology to teach foreign languages. In fact, the ability to program the presentation of the video images creates an almost limitless number of applications for this technology.

Prior to actually recording the lesson material, the entire topic is thoroughly researched and stimuli are arranged in a hierarchical order of complexity. Qualified specialists in the topic area are consulted and actively participate in designing the program. Later, a storyboard is constructed outlining all of the audio and video sequences. In some instances, standard learning programs for handicapped children are adapted and formatted for use with Miss STIM.

Figure 3 provides a sample flowchart outlining how information is presented during a typical Stimware program. A concept is presented in detail using both audio and visual stimuli. Following this first tutorial, the student is asked to respond using the keypad. If the response is correct, the student is rewarded and the next concept is presented. If the response is incorrect, the same information is presented in a second tutorial which has been modified to facilitate learning. Again, the student is tested and rewarded for a correct response. If the student fails again, a third, and final tutorial (a "super" tutorial) is presented. If the student fails at this level, Miss STIM terminates the program and notifies the instructor that the student needs tutorial assistance.

Both the main lessons and the second/third tutorials are constructed to insure that material flows smoothly between story segments without omitting important information. Further, the reward segments were carefully designed to be both fun and stimulating for the student. Typically, a reward will involve having one screen change color or begin flashing while the second monitor displays an object spinning around (such as a pinwheel).

The physical layout of the lesson material onto the laser disc varies considerably from the construction process used when recording a regular analog record. Since the audio and video tracts change constantly during the tutorial, the stimuli need to be laid out in a sequence that minimizes the amount of time needed to jump between segments. During operation, the video disc player can jump from the beginning to the end of the program in less than two seconds. Regardless, during this brief period, the screen becomes inactive and the picture "freezes" (or goes blank) while new material is being located.

To keep the lesson progressing without interruptions, certain audio and video segments were physically located adjacent to each other. This helped reduce the amount of time needed for the video sequences to be located and accessed by the video disc player. In certain instances, it was decided to insert the student's name at the beginning of a statement (to help focus attention). Specific audio segments were recorded with spaces reserved for the student's name. The computer, at the beginning of the program, loads the name into memory and recalls it at the appropriate moment. At other times, only a portion of an audio segment is presented to the student while the remaining section of the signal is omitted. Later, when the program returns to the same segment of the program, the entire audio signal is presented to add a degree of diversification.

Conclusion

The use of interactive video technology will provide a new and significant contribution to the area of Special Education. Miss STIM utilizes this technology to serve as a dynamic teaching aid.

The hardware configuration contains numerous advantages including the use of cost effective, fully tested and commercially available electronic components that are simple to operate. Importantly, each device is supported by its own warranty and service organization.

Much will depend on the forthcoming Stimware Tutorials. They have the potential to stimulate and hold the student's interest, increase motivation, and expand the capacity to learn using auditory, visual, and tactile modalities. This new teaching "aide" will prove to be affordable and indispensable addition to the Special Education classroom.

References

Fried, B.A., and Knoppel, C.A. (1984). Teaching Computers to Teach. *Proceedings of the 1984 CTG Conference*. Minneapolis, Sept. 14, 1984.

Knoppel, C.A., and Fried, B.A. (1984). Dealing with Computer Handicaps in Special Education Applications. *Proceedings of the 1984 CTG Conference*. Minneapolis, Sept. 14, 1984.

Schawlow, A.T., and Schawow, A.L. *Our Autistic Son*. Chapter in a forthcoming book entitled Integrating Moderately and Severely Handicapped Learners: Strategies that Work. Charles Thomas Publishing Company.

Slaton, A. (1985). Videodiscs in Education. *The IICS Journal*. Vol. 3(7), 1-9.

Appendix 1

Main Computer Program Menus and Sub-Menus Used While Operating Miss STIM

MAIN MENU

1) Load Student Disk
2) Review Student Disk
3) Review Course Catalog
4) Check Out Equipment
5) Systems Utilities
6) Shut Down System

SUB-MENUS

1) Load Student Disk

1)List Lessons Completed
2) Continue Last Lesson
3) Begin Next Lesson
4) Repeat a Previous Lesson
5) Select a New Course/Lesson
6) Return to Main Menu

2) Review Student Disk

1) List Lessons Completed
2) Review Responses for a Lesson
3) Review a Lesson
4) Stimulate a Lesson
5) Return to Main Menu

3) Review Course Catalog

1) Review Course Titles
2) Read Course Summary
3) List of Prerequisite
4) Return to Main Menu

4) Check Out Equipment

1) Video Disc Players
2) Video Cassette Recorder
3) STIM Response Unit
4) Disk Drive A
5) Disk Drive B
6) Printer
7) STIM Control Unit
8) Return to Main Menu

5) Systems Utilities

1) Prepare New Student Disk
2) Validate Student Disk
3) Print Student Summary File
4) Print Student Lesson Review
5) Return to Main Menu

6)Shut Down System

1) Rewind Video Cassette
2) Take Out Video Discs
3) Take Out Program Disc
4) Take Out Student Disc
5) Take Out Video Cassette
6) Switch Off System
7) Return to Main Menu

Appendix 2

October 1985 Schedule of Stimware Productions

Special Education Series

Title: "Elementary Survival Skills"
A 12-chapter interactive Stimware course tutoring the minimum skills desired in severely communications handicapped children for individual and group functions in a school environment. Scheduled release Sept. 1986.

Title: "Elementary Communication"
Addresses serve communications handicaps in the very young (autistic, etc.) by stimulating spoken, written, signed and/or electronically typed expression. Scheduled release Dec. 1986.

Title: "Elementary Signing"
Basic tutor in American Sign Language for the novice. Live camera and dual monitor techniques allows the student direct and instant comparison of his signing with tutor's sample. Scheduled release March 1987.

Title: "Elementary Learning"
A course in learning techniques for the Learning Handicapped. Evaluate student's problem, recommends learning approaches and provides interactive instruction. Scheduled release May 1987.

Therapeutic Series

Title: "Speech Therapy"
Starts with basic speech formation. Steps through progressive exercises where patient can follow therapist while observing self on monitor. Presents A/V replay comparisons. Scheduled release Jan. 1987.

Title: "Memory Builder"
One-on-one interactive course in retention development and memory restoration. For the brain-damaged patient and for general use, where needed. Scheduled release June 1987.

Employment Series

Title: "Job Tutor for the Handicapped"
Confidence-building interactive set of analytical chapters that prepare the handicapped for gainful employment. Tutors team and individual performance, compensation, taxation, etc., etc. Scheduled release April 1987.

Title: "Employment Tutor"
Unemployment Office Tutor in job-hunting skills (attitude, how to apply, interviewing). Analyzes individuals talents and suggests directions. Includes basic retraining instruction. Scheduled release July 1987. Subject to change without notice.

# # #

A Keyboard Emulator For The IBM PC

Ronald W. Lodewyck
California State University, Stanislaus
Turlock, CA

Introduction

Like any typical teenager, Jim has plans of a professional career someday. Unlike a typical teenager, however, Jim is also a quadriplegic, paralyzed from the nose down as a result of a spinal cord injury suffered two years ago in a bicycle/automobile accident. Before the accident, Jim enjoyed working with computers at school and demonstrated a real talent in this area. After the accident, Jim remains confident that he can make use of recent advances in computer technology to assist him pursuing a professional career, perhaps in the computer industry itself. To accomplish this goal, however, he would have to be able to access a computer as fully as any other person. Specifically, he would require a means of running conventional commercial software.

Several constraints were established to help Jim meet his career objective:

1. The IBM PX/XT microcomputer would serve as his primary learning tool. This computer was selected for several reasons:
    - a. It has become the de facto standard for business microcomputers.
    - b. Extensive professional software tools and learning packages are readily available from many sources.
    - c. An internal hard disk eliminates the necessity of changing floppy diskettes.
    - d. An open, flexible architecture provides essentially unlimited future expansion capabilities.

2. The access method must use a single-switch input device. Jim

is able to open and close a switch contact by raising or lowering his eyebrow. Since he is paralyzed from the nose down, this is the only external control he has.

3. The access method should be 100% compatible with unmodified commercially available software. This constraint implies that the access method must be a totally transparent emulation of the computer keyboard. Early investigation showed that methods using redirection of the keyboard device, such as the IBM PCDOS CTTY command to change the standard input console to the serial port, or using alternate device drivers are not acceptable since a lot of software circumvents the standard DOS function calls. This includes such important programs as IBM, BASIC, WordStar, Lotus 123 and DBASE II.

4. The computer should continue to allow conventional keyboard input by a non-handicapped person. This is desirable so that an aide could enter, install, modify or delete the software packages on the hard disk and also to provide a straightforward override method.

5. The cost to provide the access method should be reasonable.

First effort

An early attempt to use the Radio Shack TRS80 Model 100 battery operated lap-top portable computer as a keyboard emulator proved unacceptable. The Model 100 was programmed to run a Row/Column scanner with the eyebrow switch connected across the contacts of a key on the Model 100 keyboard. Closing the switch was equivalent to pressing this key on the Model 100 keyboard. The scanner program looked for this key to be pressed to signal "stop scanning." The model 100 RS232 serial port was connected to the IBM PC/XC COM1: serial port and the IBM CTTY command was used to redirect the keyboard to the COM1: port. This system worked -- to a point: the Model 100 could emulate the keyboard so long as the software running on the IBM PC/XT used the standard PCDOS function calls. This included PCDOS commands (such as DIR, COPY, ERASE, etc.) and a few popular programs (such as SuperCalc3), but did not include many popular programs (such as BASIC, WordStar, Lotus 1123 and DBASE II). Another problem encountered was that Jim had difficulty reading the LCD screen of the Model 100. This approach was quickly abandoned in favor of a system which emulated the IBM keyboard directly and used a standard CRT display.

The System

About the same time as the Model 100 system was being abandoned, it was learned that ZYGO Industries[1] marketed a microcomputer keyboard emulator designated the TETRAscan II. The TETRAscan II looked good, but it appeared that there would be some delay since the interface for the IBM PC/XT was not yet available. It was therefore decided to go ahead and design and build an access system which would meet all of the desired constraints.

The system is based on the use of a low cost home computer running a Row/Column scanner and generating IBM PC/XT compatible keyboard scan codes. A block diagram of the system is given in Figure 1. A simple interface circuit was constructed which allowed both the home computer and the IBM keyboard to be connected to the IBM PC/XT. The output of the home computer essentially plugs into the IBM PC/XT keyboard input connector and has the same voltage levels and timing as the scan codes coming from a standard IBM PC/XT keyboard. Since the home computer is programmed to generate the scan codes of every possible key combination, the system totally emulates the keyboard.

Home Computer

Several home computers were tried and all of them proved acceptable. The ATARI 400 and 800, Commodore VIC-20 and C64 and Radio Shack TRS-80 Model III home computers were all successfully interfaced and programmed to generate the necessary scan codes. The ATARI 400 was chosen for complete implementation due to its extremely low cost and ease of interfacing. The complete home computer system consisted of an ATARI 400 computer, an ATARI 1050 disk drive and a small portable TV. Since the TV was already available, the total cost of the system was under $300.

Software

The home computer software consisted of two principle components: Row/Scanner menu selection, and IBM keyboard scan code generation. The program was written in BASIC with an assembly language subprogram to generate the scan codes. The assembly language subprogram was necessary on the ATARI 400 to ensure proper timing of the scan codes. It was necessary to use assembly language on any of the other home computers; the entire program, including scan code timing, was written in BASIC on the other home computers. The ATARI 400 required the assembly language in order to avoid unpredictable variations in the timing caused by the vertical blank interrupt used in the ATARI operating system.

Scanner Design

The home computer serves as a front-end preprocessor to the IBM, transforming make-break single switch closures into keyboard scan codes. This is accomplished by means of a Row/Column scanner program which displays a matrix of options on the screen of the home computer. The user first selects the row that the desired option is in by closing the switch at the time when a moving cursor points to the appropriate row. The cursor then begins traversing columns in the currently selected row. The user then selects the desired option by closing the switch when the cursor moves into the appropriate column.

Three different strategies for the design of the scanner layout were programmed and tested:

1. The first strategy called for the screen display to look virtually identical to the IBM PC/XT keyboard layout. This layout tends to appear appealing to the non-handicapped person since it is easy to understand the relationship to the actual IBM keyboard. However, it proved to be disappointing in terms of performance efficiency. The layout of keys on the IBM keyboard (or any QWERTY keyboard for that matter) does not correlate with the frequency of use of those keys. The cursor movement keys (arrows), for example, are used very frequently in most programs, yet they are located in the lower right corner of the keyboard. Similarly, the space bar is very frequently used and is located in the bottom row. (Reversing the row/column order does not help since there are keys on the top or left side which are just as frequently used.) This strategy was discarded in favor of a frequency-of-use determined layout.

2. The second scanner strategy used a screen display which is based on the frequency of use of keys, with the most frequently used

keys in the upper left corner and least frequently used keys in the lower right corner. The frequency of use was determined subjectively and continues to be part of the system needing refinement based on experience. It is not necessarily true that the frequency of use for a standard typewriter would be the same for a computer keyboard, since many special purpose control keys tend to be frequently used on the computer (e.g. cursor movement, CTRL, Esc, etc.). In order to accommodate all of the keys on the IBM keyboard, the matrix would have to be at least 10 rows by 10 columns. Since the maximum access time is determined by the number of rows plus the number of columns, it is desirable to keep the size of the matrix as small as possible. A tree of menus was developed which kept the maximum matrix size to 6x6. As seen in Figure 2a, the main menu consists primarily of the letters of the alphabet with a few other very frequently used keys, such as SPACE and RETURN. The main menu also contains options which select submenus for number, control and punctuation. For example, the number 1.2 would be selected as follows:

a. Select row 4, column 1 (number).
b. The number menu will appear as shown in Figure 2b.
c. Select row 3, column 1 (1).
d. Select row 4, column 3 (.).
e. Select row 4, column 1 (2).
f. Select row 5, column 4 (Main)
g. The main menu will reappear as shown in Figure 2a.

A similar scheme works for control and punctuation keys. For the control menu, note that four keys are treated as toggles: CTRL, left shift, right shift, and Alt are all assumed to be held down until they are selected a second time. This allows key combination such as: CTRL-NumLock (used to stop scrolling), CTRL-Alt (used to invoke some co-resident programs), CTRL-Alt-Del (used to reboot the system), and even LeftShift-RightShift (also used to invoke some co-resident programs).

Worthwhile mentioning is the function key submenu which is called from the control key menu (Figure 2c.). To press function key F5, the user would:

a. Select row 5, column 1 (CNTRL).
b. The control menu will appear as shown in Figure 2c.
c. Select row 4, column 5 (FCN).
d. The Function Key submenu will appear as in Figure 2e.
e. Select row 1, column 2 (F5).
f. The main menu will reappear.

Note from the above example that the function key menu returns automatically to the main menu after a single key is selected. This was done since it was not found to be common to press two or more function keys in sequence. By contrast, the number, and upper case menus remain displayed for additional selections until the "main" option is selected since it was found that such keystroke sequences were common.

This layout works quite well, but an improvement was desired to accelerate input efficiency through the use of specialized layouts.

3. The final strategy is an extension of the layout in 2. above

to include additional submenus with specialized layouts tailored to specific applications. For example, a BASIC programming layout would include options like: RUN, LIST, SAVE ", PRINT USING, etc., and a word processing layout would include cursor movement keys, INSERT mode toggle, PRINT current file, etc. Also included in this design is the ability to create custom layouts with each option fully user programmable. This design required a lot of programming which ultimately proved unproductive. It proved to be unproductive for two reasons. First, it created confusion as the menu structure became more complex. Second, it turned out that using an external program, resident on the IBM PC/XT, was more flexible. Several outstanding programs (SuperKey, SmartKey, ProKey, etc.) are available commercially for PCDOS which allow the user to program any key on the IBM PC/XTR. This proved to be a better solution since the commercial programs were easy to use and very flexible. The third strategy was therefore rejected in favor of the second layout strategy used in combination with commercial software resident on the IBM PC/XT to program the keys fro each application.

Scan Codes

The home computer software converts the character (or characters) selected from the scanner menu into IBM keyboard scan codes. These scan codes are then directed to an output port which is connected to the IBM keyboard input connector by means of an interface circuit. Associated with each of the 83 keys on the IBM keyboard is a unique position number, from 1 to 83, called the scan code. The keyboard sends this scan code to the computer whenever the corresponding key is pressed. In addition, all keys except control keys generate the scan code + 128 when the corresponding key is released. For example, the "A" key generates a scan code of 30 when it is pressed and a scan code of 158 when it is released. This system allows the computer to detect and auto-repeat keys which are held down for a specified period of time.

The binary representation of the scan code is sent serially to the computer over a line designated "Keyboard Data." The eight bit number is sent least significantly bit first. The timing of the data consists of two elements: bit length and clocking. The bit length is not critical; bit lengths from tenths of a millisecond to several seconds were tried with success. Clocking consists of a second line to the computer designated "Keyboard Clock" and serves to indicate the start and stop of each scan code and the bits within each code. In effect, the clock line tells the computer when to read the next bit on the data line. The temporal relationship of the clock line must be precisely coordinated with the transitions of the data line. This relationship is depicted graphically in Figure 3 for the scan code 2, which is associated with the "1" key.

It was necessary to write an assembly language subprogram to generate the scan code timing and clocking on the ATARI home computer in order to avoid time variations caused by a vertical blank interrupt generated by the ATARI hardware every 1/60 second. The scan code is passed as a parameter to the assembly language subprogram which then sends the appropriate data and clock signals out the ATARI game controller port. This subprogram also generates a third signal to the game controller port which tells the hardware interface that the scan code is coming from the home computer rather than the standard keyboard. This signal is discussed in the following section.

Hardware Interface

The IBM keyboard input circuitry expects TTL level (0 / +5v) signals for both the data and clock lines. Since this is precisely what the ATARI game controller port puts out, it is possible to directly connect the ATARI port to the IBM keyboard input connector. The only hardware required is a three wire cable with an ATARI game controller port female connector on one end and a male 5 pin DIN connector on the other. This was tried and found to work acceptably. It requires, however, that the keyboard be disconnected. An interface circuit was therefore designed and constructed which allows both the home computer and the keyboard to be connected to the IBM. The schematic diagram of the interface circuit is shown in Figure 4. All of the parts required are available from any local electronics supply store (e.g. Radio Shack) and the total cost of the parts is under $20. The emulator connector P1 is attached to a cable which plugs into the ATARI 400 game controller port 1, the IBM CPU connector P2 is attached to a cable which plugs into the IBM keyboard connector on the rear panel of the IBM PC/XT CPU cabinet, and the connector on the end of the cable from the IBM keyboard plugs into connector P3 on the interface cabinet. In this configuration, input to the IBM PC/XT can come from either the keyboard emulator or the standard keyboard.

TETRAscan II

About the time that this project was nearing completion, ZYGO Industries TETRAscan II for the IBM PC became available and Jim was able to obtain one. It uses a system design very similar to that presented in this paper except that the scanner is a self-contained unit with an LED display. The main advantage of the TETRAscan II system is the ease with which it is installed; it took less than an hour to have everything connected and operational. Another advantage of the TETRAscan II is the small size of the scanner unit; it's not much larger than a typical notebook. The small size makes it easy to locate in the line of sight with the IBM PC/XT video monitor and close to Jim. No special mounting brackets are required and Jim can view both displays quite easily. By contrast, the TV monitor associated with the home computer scanner is considerably larger than the TETRAscan Ii and not as convenient to locate in front of the handicapped user.

The TETRAscan does have its disadvantages, however. For one thing, it costs approximately $2,500, making it considerably more expensive than the keyboard emulator described above. Secondly, the display unit incorporates a fixed scanner layout. While the layout used is certainly a good one for creating plain English text, it is not necessarily the best for all applications. For example, while using a spreadsheet it is necessary to enter a lot of numbers; these are placed at the maximum scan time in the lower right corner of the TETRAscan display unit. The digit 9 would require waiting for seven rows and seven columns, a total of 14 time scan periods, in order to be selected. By contrast, with the home computer scanner design presented here, it would require one row and four columns followed by one row and four columns, a total of 10 time scan periods, to select the digit 9. The point of this is not that the home computer scanner layout suggested here is superior to the TETRAscan layout. Rather, the point is that a flexible system, which allows for the design and implementation of a scanner layout designed to fit the individual's needs will be more efficient in the long run. In fact, it is apparent that more experience is needed, and considerable refinement is necessary, before an optimal scanner design to best fit Jim's (or any other severely physically handicapped person's) needs can be developed.

Experience

The keyboard emulator has allowed Jim to have virtually full control over an IBM PC/XT microcomputer. He is now able to effectively use standard off-the-shelf commercial software written for the IBM PC/XT. He has been using:

a. WordStar[2] to write letters to family and friends and to complete his homework assignments.

b. SideKick[3] to access a calculator and notepad.

c. ProKey[4] to program keys with specialized words, commands and frequently used phrases in conjunction with WordStar and other programs.

d. LOGO and BASIC to program the computer. Jim is especially interested in graphics and writes programs to solve his geometry homework assignments.

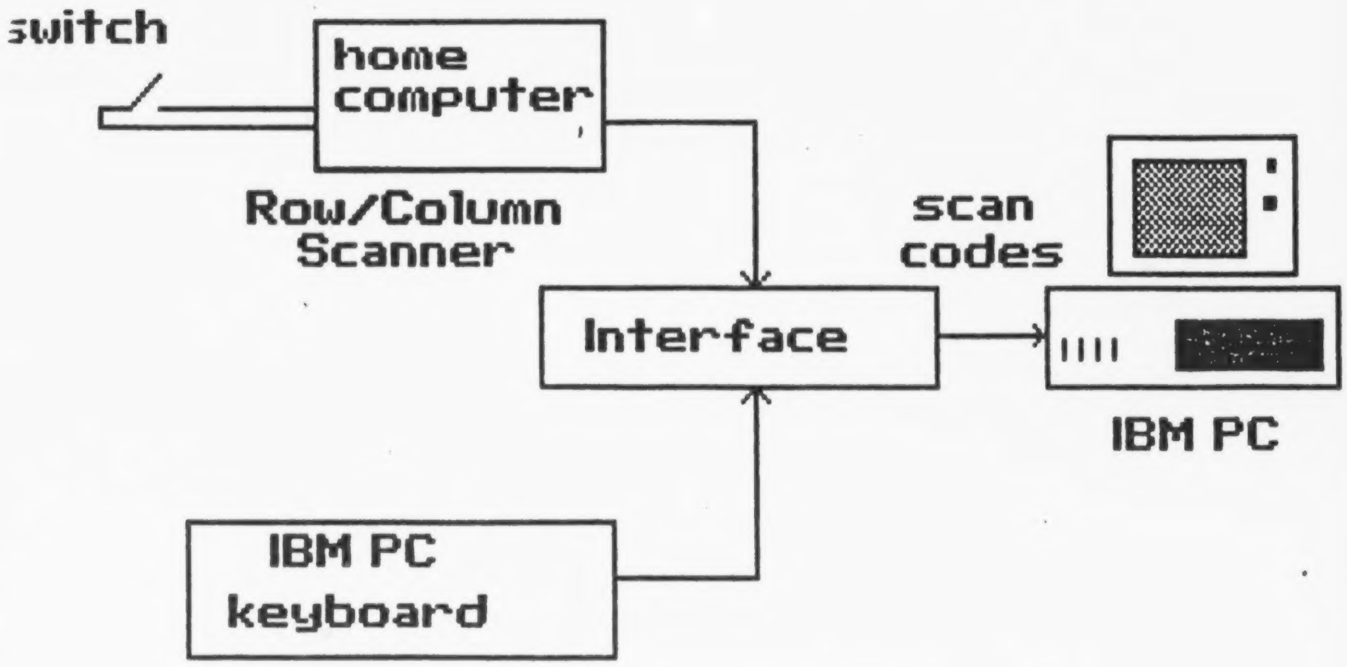
e. RADIOACTIVE[5], a custom program, to control a shortwave radio.

Conclusions

The keyboard emulator described in this paper has made it possible for a severely physically handicapped individual to have essentially full control over an IBM PC/XT microcomputer. This emulator approach is easy for the handicapped person to learn and use efficiently. Being written primarily in BASIC, it is also easy to customize the design to fit the needs of the individual. This is especially important with regard to the design of the scanner layout. The disadvantage of this system, however, is that it requires construction of an interface circuit. If this presents an insurmountable task for the implementer, it is recommended that the TETRAscan II unit be purchased from ZYGO Industries.

While the scanner design suggested in this article works quite well for a variety of applications, more research is necessary to achieve even greater input efficiency. One possible enhancement to the basic scanner design is a capability to reverse scanning order whenever the single switch contact is held closed for a longer time period, say a second or more. This would allow very rapid access to both halves of the matrix, as delineated along a diagonal. This feature is currently being investigated.

The source code for the ATARI 400 and 800 home computers and detailed construction plans for the interface circuit are available for nonprofit use, free of charge from the author. Simply send a blank, formatted diskette and a stamped, self-addressed, padded envelope large enough to accommodate the diskette.



The IBM PC Keyboard Emulator System

```
==========================================
SPACE    e       o       u       s       f
i        a       n       g       v       p
RETRN    t       w       h       j       l
NUMBR    r       d       b       q       .
CNTRL    k       m       x       z       DEL
SHIFT    c       y       ,       PUNCT   -
==========================================
```

Figure 2a. Main scanner menu (Lower case characters).

```
==========================================
SPACE    3       7       9       ;
0        4       8       -       =
1        5       ,       '       `
2        6       .       [       ]
/        \       Shift   Main    RETRN
==========================================
```

Figure 2b. Scanner Number menu.

```
==========================================
CapsLk   Backsp  Tab     Right   Esc
Ctrl     Del     Left    Numlk   Home
Alt      Down    Break   End     RESET
Up       Ins     PgDn    Rshift  FCN
Lshift   PgUp    PrtSc   Main    RETURN
==========================================
```

Figure 2c. Scanner Control menu.

```
==================================
SPACE    #      &      (      :
)        $      *      _      +
!        %      <      "      tilde
@        ^      >      {      }
?        ¦      Back   DEL    INS
==================================
```

Figure 2d. Scanner Punctuation (Shifted Numbers) Menu.

```
==========================================
F1         F5         F9
F2         F6         F10
F3         F7
F4         F8
==========================================
```

Figure 2e. Scanner Function Key submenu.

```
=========================================
SPACE   E    O    U    S    F
I       A    N    G    V    P
RETRN   T    W    H    J    L
number  R    D    B    Q    .
contrl  K    M    X    Z    DEL
punctn  C    Y    ,    ?    _
=========================================
```

Figure 2f. Shifted Main scanner menu.

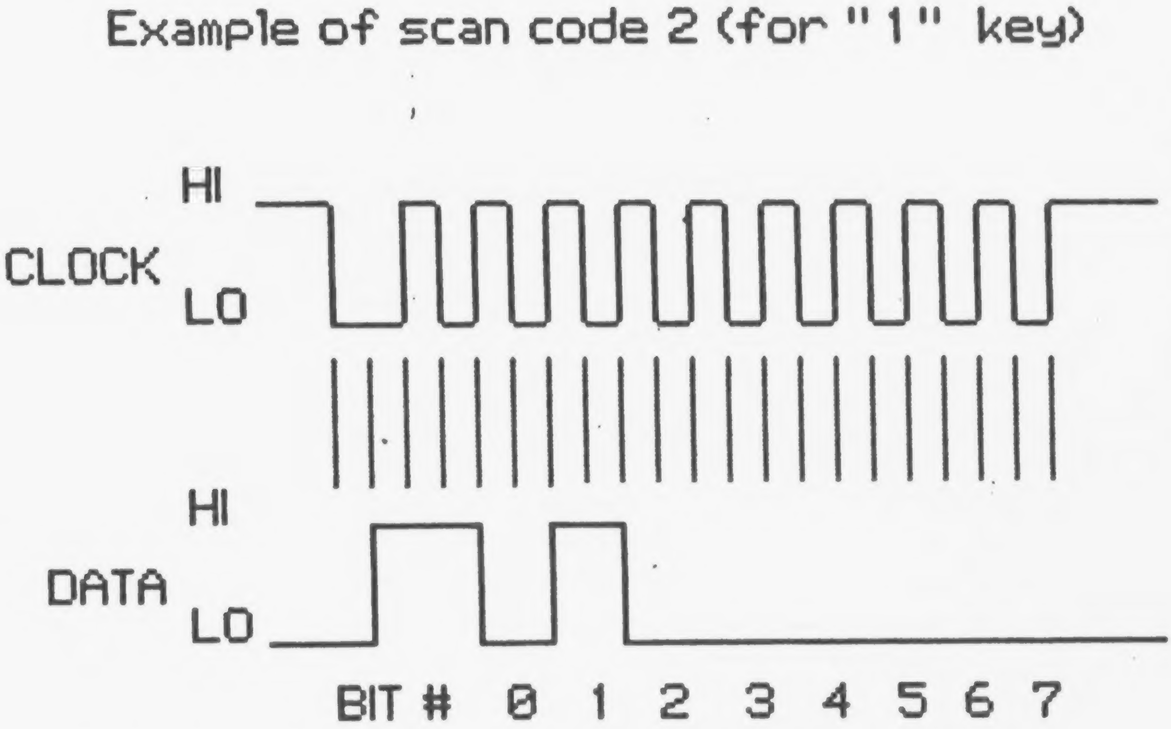


Figure 3. Scan Code Timing Diagram.

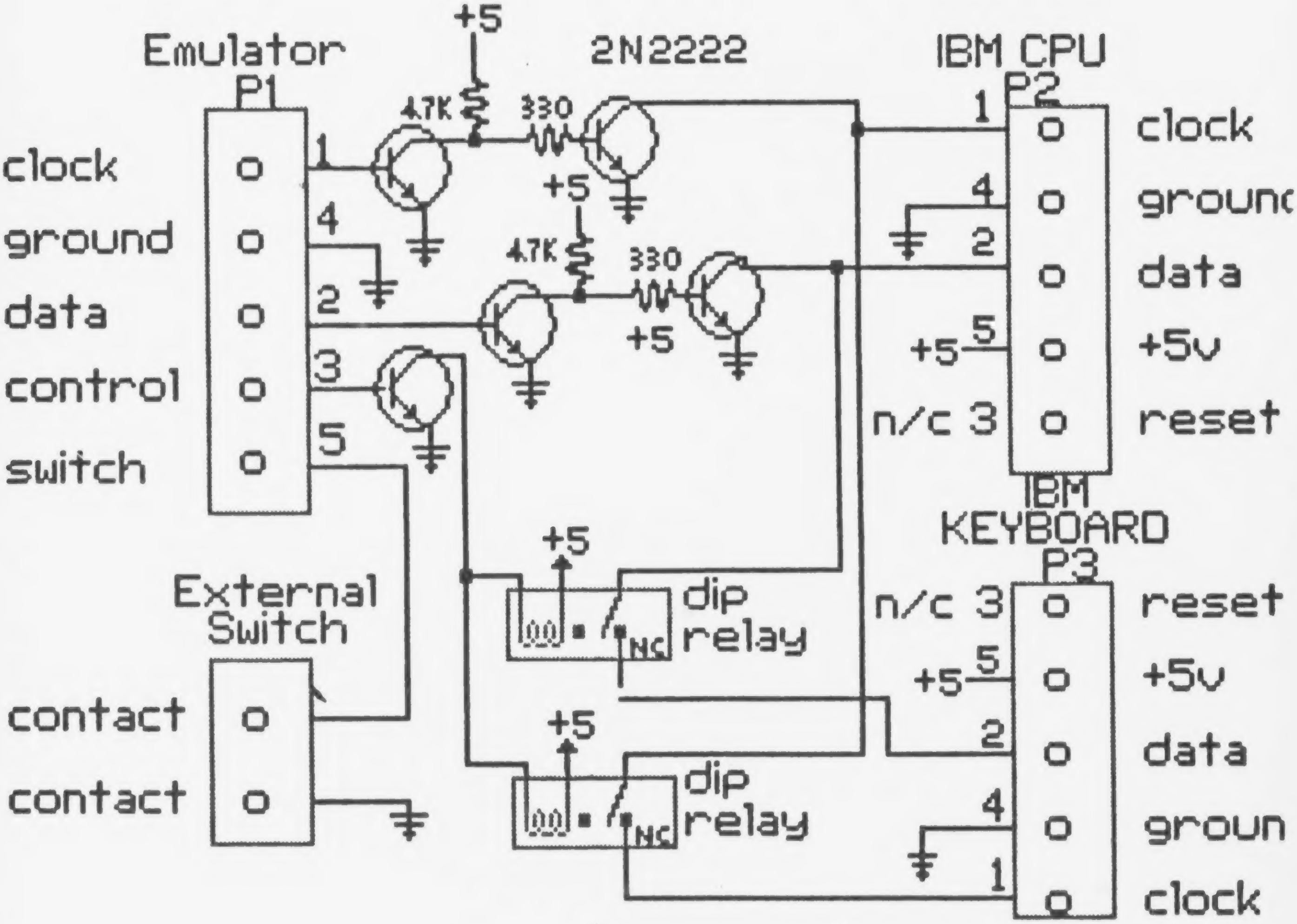


Figure 4. Interface Schematic Diagram

References

1. ZYGO Industries, Inc., P.O. Box 1008, Portland, OR 97207-1008 (503) 297-1724.

2. WordStar is a product of MicroPro International Corporation, P. O. Box 7040, San Raphael, CA 94901.

3. SideKick is a product of Borland International, 4113 Scotts Valley Drive, Scotts Valley, CA 95066.

4. ProKey is a product of RoseSoft, 4710 University Way N.E. Seattle, WA 98105.

5. Lodewyck, Ronald., RADIOACTIVE, a paper presented at the Computer Technology and Persons With Disabilities Conference, California State University, Northridge, October 18, 1985.

# # #

RADIO ACTIVE:
A Microcomputer Based Radio Access System For The Severely Physically Handicapped

Ronald W. Lodewyck
California State University, Stanislaus
Turlock, CA

Introduction

Severely physically handicapped individuals are often limited to the use of a single on/off switch. These switches take many forms, depending on the nature of the individual's particular handicap. Examples of common switch devices include: mouth bite, sip & puff, eyebrow lift, eyelid blink, head sway, etc. Through the use of a microcomputer interface and appropriate software, a single switch can be enhanced to allow control of a wide variety of devices. This paper details the design, construction and use of a microcomputer interface and software to control a radio.

Radios

Standard AM, FM and shortwave broadcast radios require sufficient physical dexterity to control a variety of tuning dials and knobs. Typically, the ON/OFF switch has to be pushed or twisted, and the volume control and tuning dial have to be rotated in order to minimally control the radio. Within the past year or two, several manufacturers of radio products have introduced digitally controlled radios which allow tuning and other functions to be activated by push button switches. The advantage of this type of radio is that the push button switches can be easily controlled by a computer using simple switch closures.

Two different radios were investigated and interfaced to the computer: the SONY ICF-2002, a low cost portable radio, and the ICOM R71A, a full featured radio primarily intended for shortwave listening. The advantages and disadvantages of each radio will be discussed in terms of cost, ease of interfacing, modes of operation and performance.

The SONY ICF-2002 is a low cost portable radio about the size of a small textbook. It offers coverage of commercial AM, FM and shortwave broadcast bands. The performance of this radio is remarkable given the low cost (under $200). The clarity of reception on all bands is superb and its use of front panel pushbutton tuning for most functions makes it a good candidate for interfacing to a computer. A detailed description of how to interface the SONY ICF-2002 is given at the end of this paper.

The ICOM R71A is a general coverage receiver designed to meet the needs of a serious software listener. Priced at around $800, it offers many exceptional and unique features which are important to the physically handicapped person. For example, the R71A is available with a wireless remote tuning device which allows direct interfacing using the same technique described for the SONY ICF-2002 of paralleling the pushbutton switches. This radio also allows controlling the volume with the computer and even includes an optional voice synthesizer which is quite helpful in confirming the frequency to which it is tuned. This feature reduces the need for the handicapped person to view the radio frequency readout panel. The R71A is outstanding for a person who would like to listen in to the fascinating conversations of amateur ("Ham") radio operators on both voice (SSB) and morse code communications modes. Unfortunately, this fine radio does not cover the commercial FM (76 - 108 Mhz) band, which greatly reduces its value for the person who would want to primarily listen to local FM stations. Detailed interfacing information for the R71A is given in Appendix B.

Computers

Software was developed on three popular microcomputers: Commodore 64, Atari 800 and IBM PC. The Commodore and Atari implementations are low cost dedicated systems which control the SONY ICF-2002, while the IBM PC version is for the ICOM R71A and assumes that the user has full use of the keyboard through emulation or other means. The dedicated versions use scanning technology to present the appropriate menu selections. The user switch is directly connected to a port on the computer and is detected by the software to determine user selections. The user is able to turn the radio power on or off, tune the radio to any AM, FM or shortwave station, and even select from a list of preprogrammed stations. See Appendix D for a diagram of the screens presented to the user with the Atari version of the software. The Commodore version is essentially the same.

The IBM PC version is more elaborate in terms of options for controlling the R71A radio. In addition to control over power, mode, frequency, and volume, this version also includes a speech synthesizer for frequency announcement and a data base of shortwave radio stations. The data base is linked to the internal clock so that a list of stations known to be active at that time of day is automatically displayed and may be selected directly from a menu. The data base includes an on-line editor to allow the user to enter new stations or edit existing stations. The entire program is designed specifically for use by persons with severe physically disabilities.

Source code to all programs is available from the author if an appropriately formatted diskette and return postage accompanies the request.

Interface

The interface circuitry is simple and straightforward. The radio itself must first be modified to allow connection to the push button switches. This merely involves attaching a connector in parallel with the switches. An interface circuit is then constructed consisting of a single chip address decoder and a set of opto-isolators or relays to activate the switches. The interface derives what little power it needs from the computer, so no additional power supply is required. See Appendix C for a schematic diagram of the interface circuit. Miniature Dip relays could be substituted for the opto-isolators with no change in the rest of the circuit.

Benefits

Being able to independently control a radio can have numerous benefits for a severely physically handicapped person. The ability to turn the radio on or off without assistance gives the handicapped person additional control over their environment. To some degree, then, it offers a measure of independence and freedom. If the radio is capable of shortwave reception, even greater benefits can be derived. Shortwave listening is not only an excellent source of varied entertainment, it can also serve a pedagogic function. For example, most countries of the world maintain shortwave broadcast stations which schedule regular programming of music (both classical and folk), international news, and talk shows about local customs, geography and so forth. Many shortwave broadcast stations also offer foreign language tutorials. For example, Russian from Radio Moscow, Chinese from The Voice of Free China, Spanish from Radio Havana, etc.

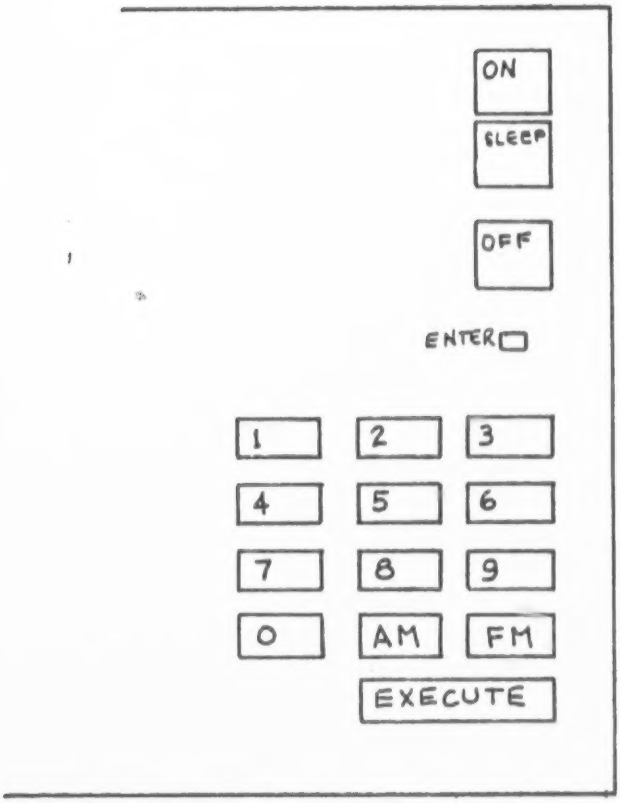
For shut-ins or persons with limited mobility, being able to control a radio has the potential of bringing many long hours of enjoyment, learning and personal satisfaction.

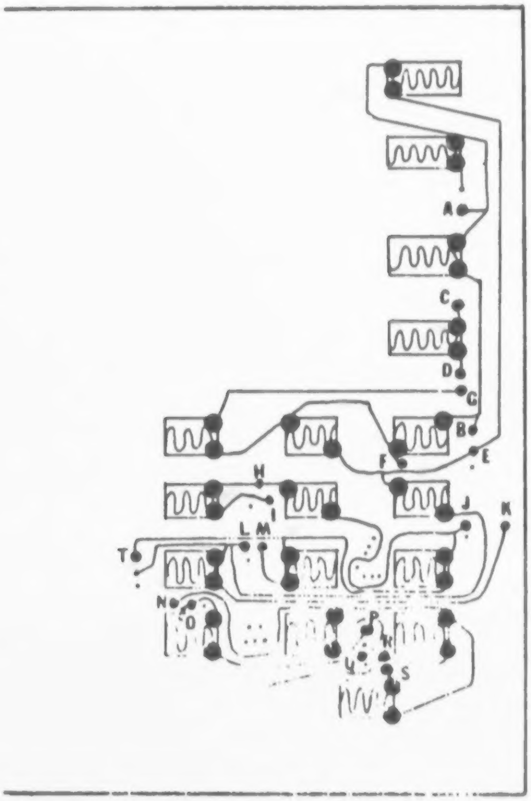
Of course, there are some problems, too. As any shortwave listener can attest, propagation conditions vary tremendously from year to year, month to month, even minute to minute! What this means is that the quality of reception is highly variable and not completely dependable. On the other hand, this variation also offers the prospects of discovery and adventure. Not knowing what you will hear from day to day heightens the excitement of listening to shortwave radio. Another problem is that some microcomputers radiate RF which directly interferes with the radio. This is not usually a severe problem however, and can typically be overcome by installing a wire antenna outside the residence. This should be done in any case to improve the quality of shortwave reception.

Appendix A - How to interface the SONY ICF-2002

To interface the SONY ICF-2002, a connector is wired across the front panel switches as shown in Figure A1. Access to the printed circuit board is attained by removing two small screws on the rear panel and through the battery compartment, then gently prying the two halves apart. The rubber membrane cover the printed circuit board should be carefully lifted up and set aside. Solder directly to the printed circuit board at the price points labeled A through T in Figure 2 using a very small gauge insulated wire, such as wire wrap wire. Route the wires between the switches and out the case near the speaker. A small notch filed in the top lid makes a simple and inconspicuous exit port. Attach the wires to a DB 25 female or similar connector as close to the body of the radio as possible.

With the interface connected to the SONY ICF-2002 using the twenty wires attached in the manner just described, it is possible to control the following functions: power (on and off), mode (AM or FM), and frequency (select preset stations 1 - 10 or enter a specific frequency).





Note: solder 20 fine wires to points A through T.

Bring wires out to a DB25S or similar connector.

FIGURE A2. SONY ICF-2002 Printed Circuit Board Solder points.

Appendix B - How to interface the ICOM R71A

The R71A is most easily interfaced by paralleling the switches on the optional R11 remote control unit as indicated in Figure B1 and bringing the wires out to a small connector, such as an IDS-20, as seen in Figure B2. Use a small gauge 20 conductor ribbon cable and exit the case at any convenient spot. Keep the connector close to the body of the remote control unit case. The remote control unit should be connected to the interface unit by means of a matching cable and then pointed so that the R71A receiver is in line of sight of the control unit.

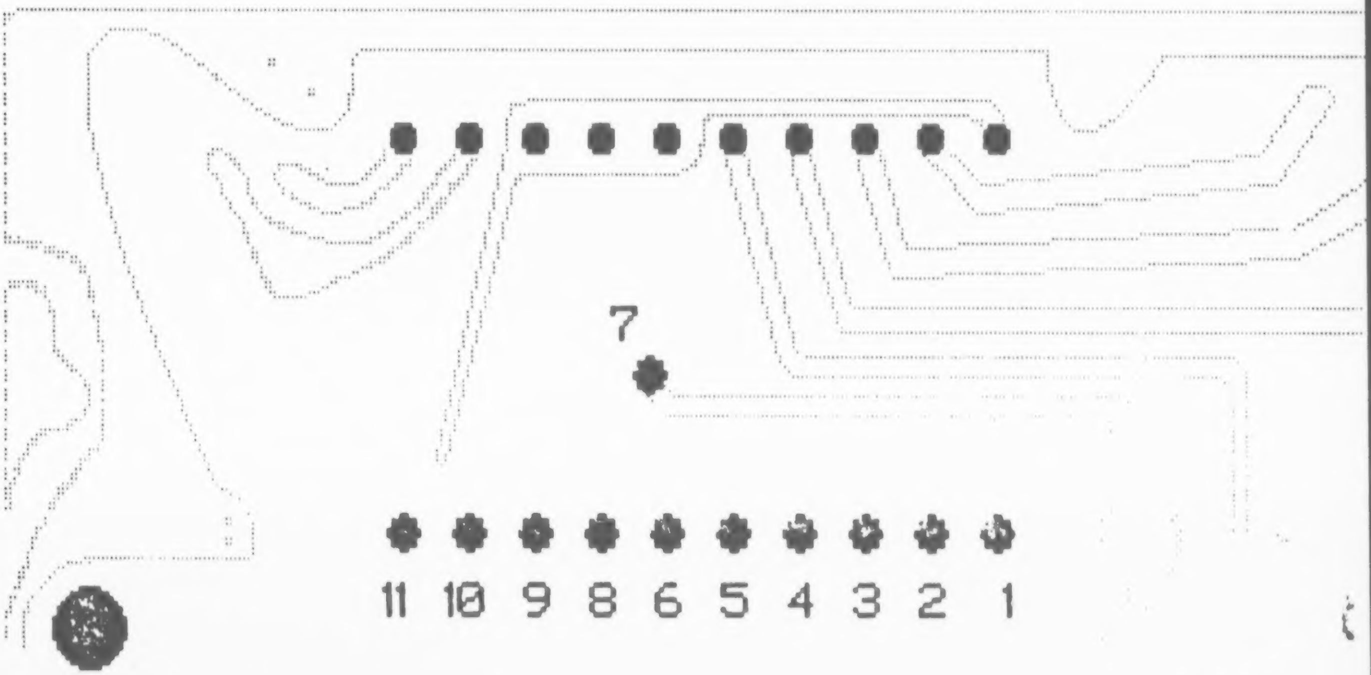

Internal connection to ICOM RC-11
Remote Controller PC board

FIGURE B1. Wiring the R11 Control Unit

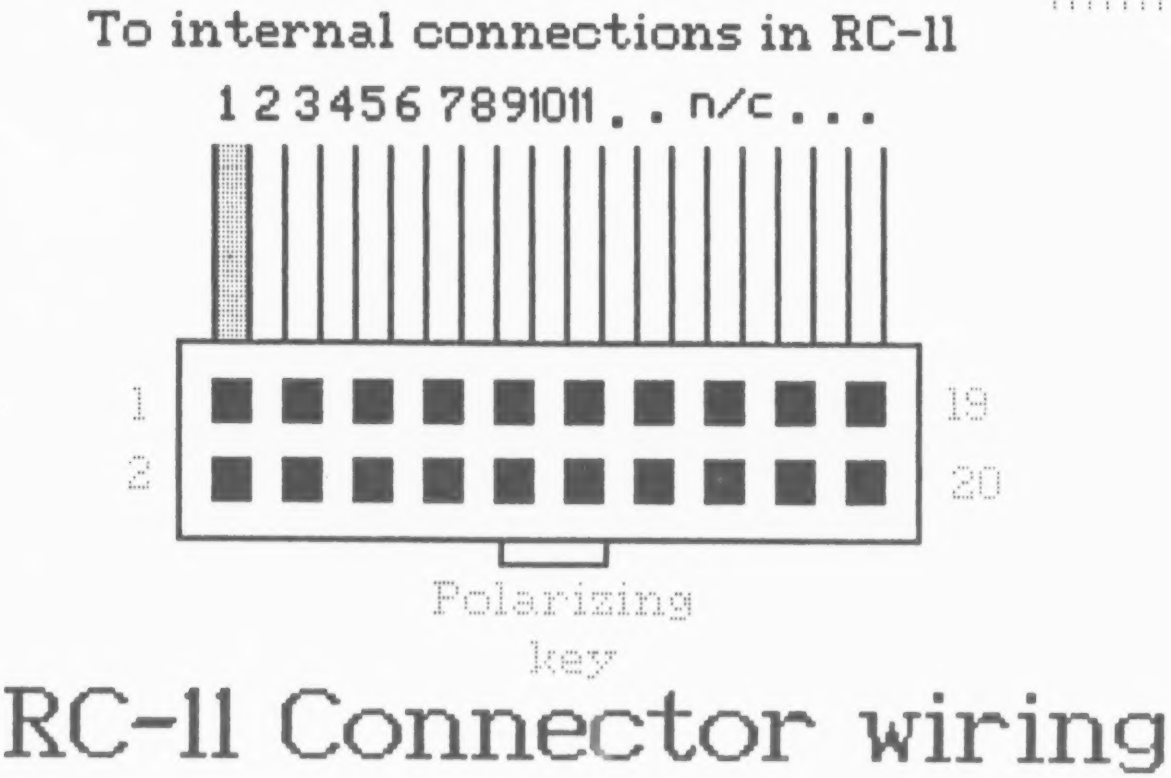
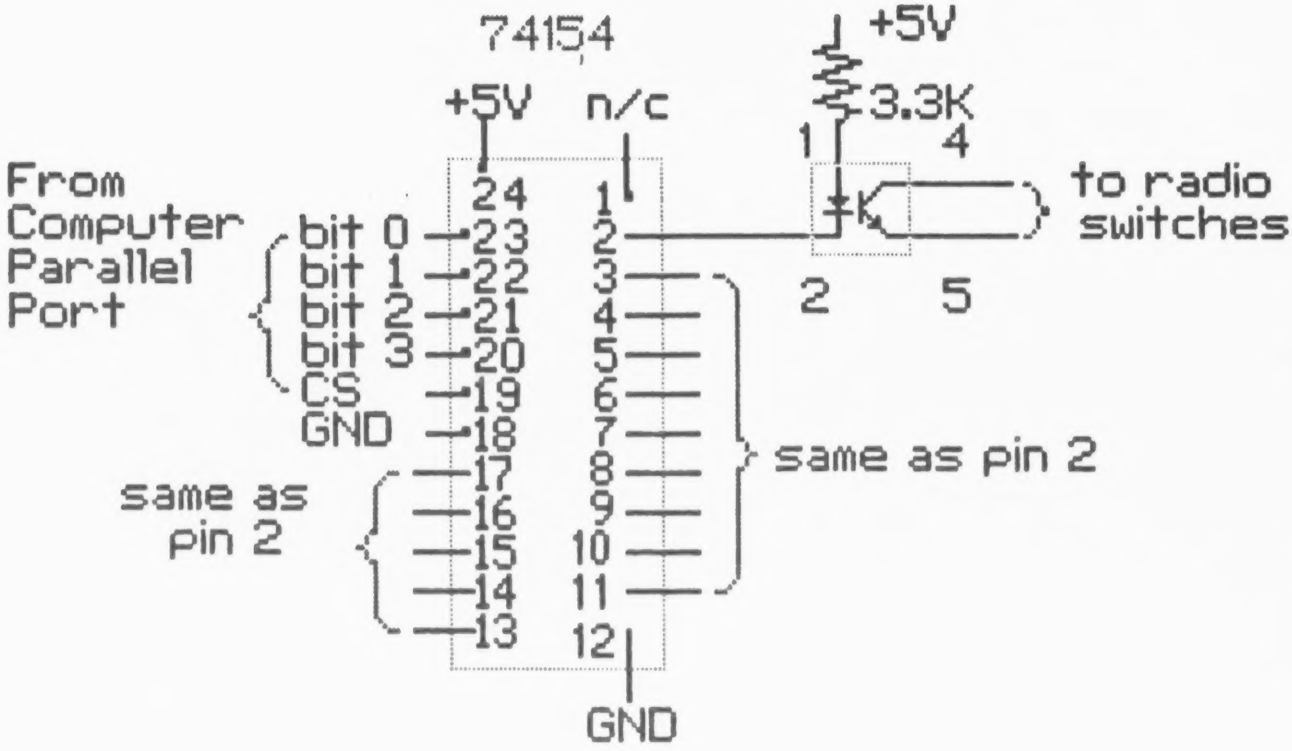
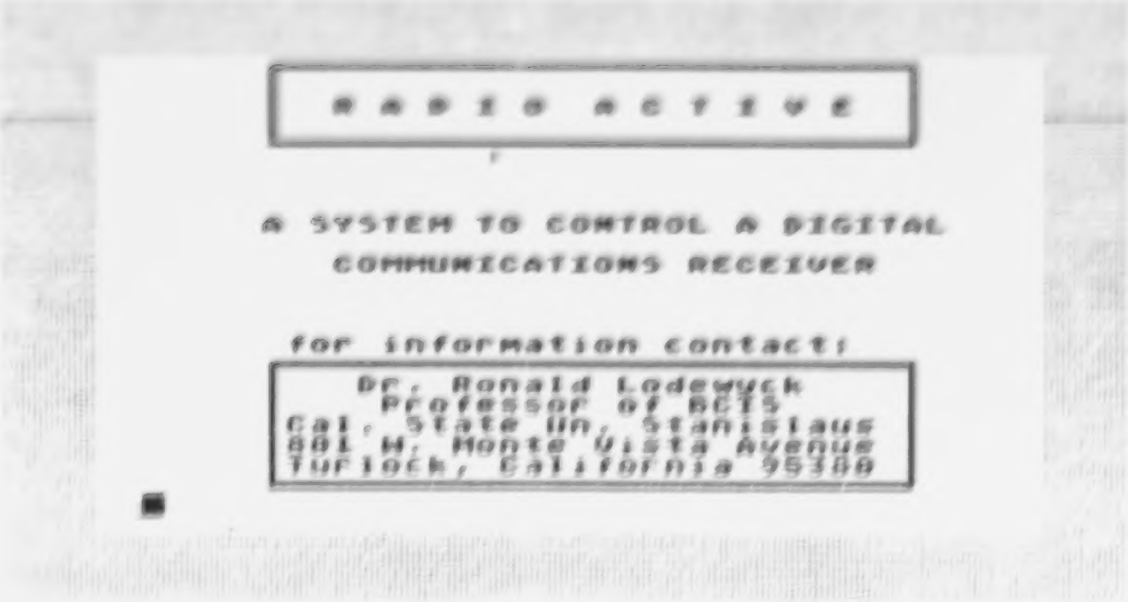

To internal connections in RC-11
1 2 3 4 5 6 7 8 9 10 11 . . n/c . . .
1
2
19
20
Polarizing
key
RC-11 Connector wiring

FIGURE B2. R11 Connector wiring.

Appendix C - Interface schematic diagram.



Parallel Port to Radio Switch Interface

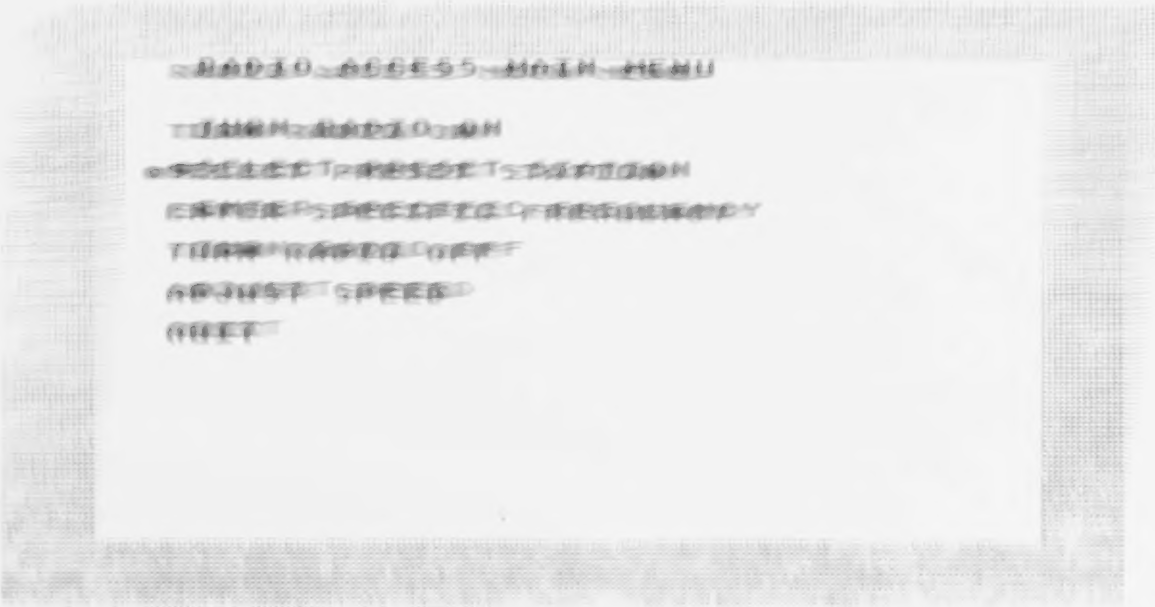


R A D I O   A C T I V E

A SYSTEM TO CONTROL A DIGITAL
COMMUNICATIONS RECEIVER

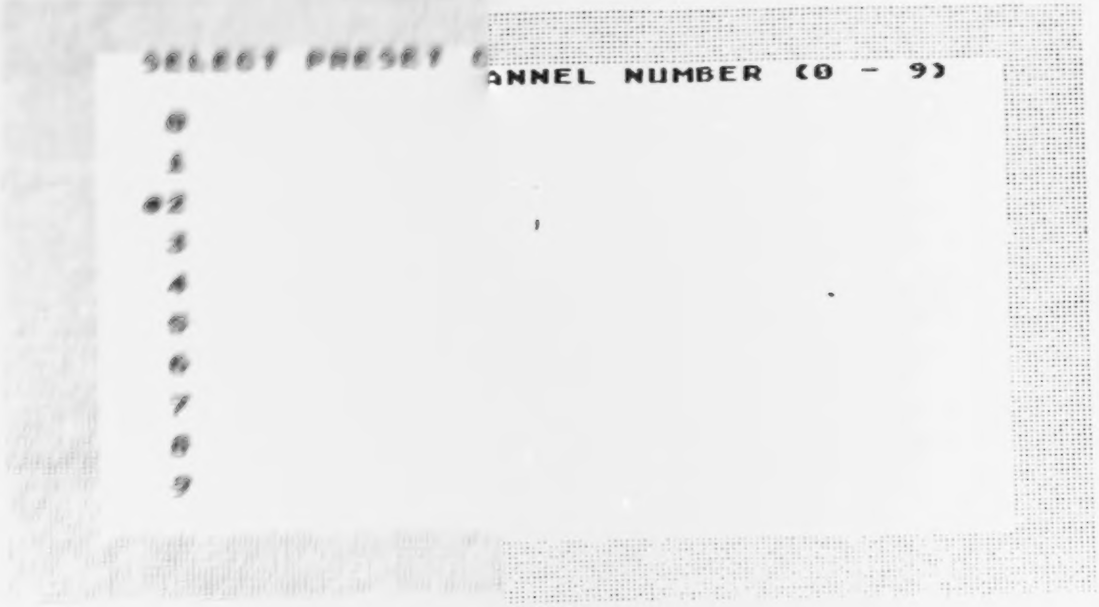
for information contact:

Dr. Ronald Lodewyck
Professor of BCIS
Cal. State Un. Stanislaus
801 W. Monte Vista Avenue
Turlock, California 95380



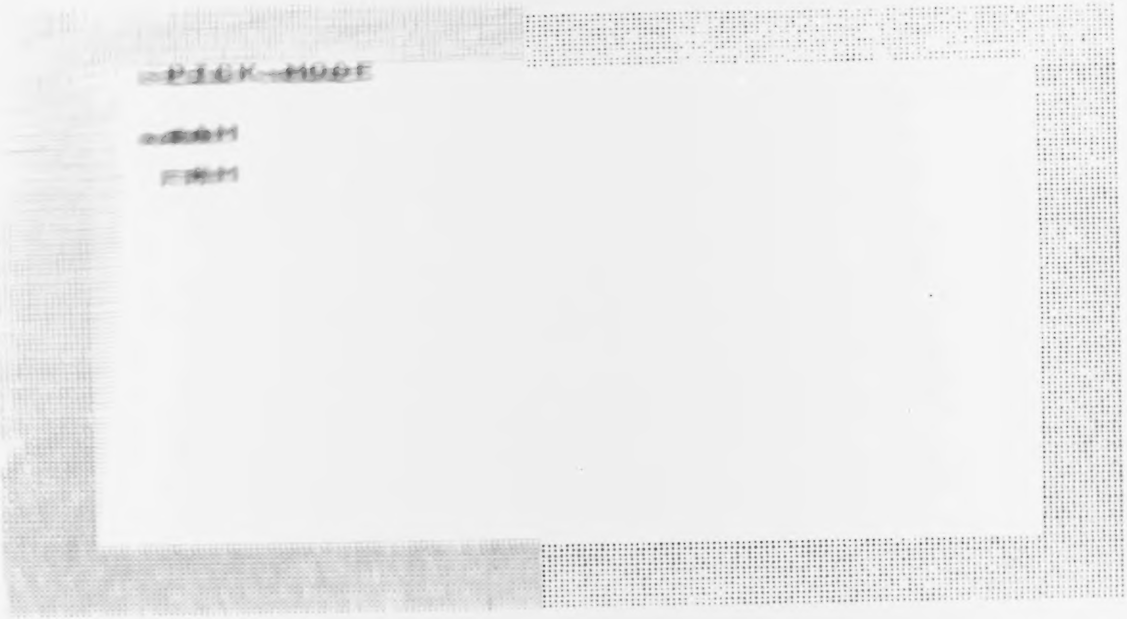
RADIO ACCESS MAIN MENU

TURN RADIO ON
SELECT PRESET STATION
ENTER SPECIFIC FREQUENCY
TURN RADIO OFF
ADJUST SPEED
QUIT



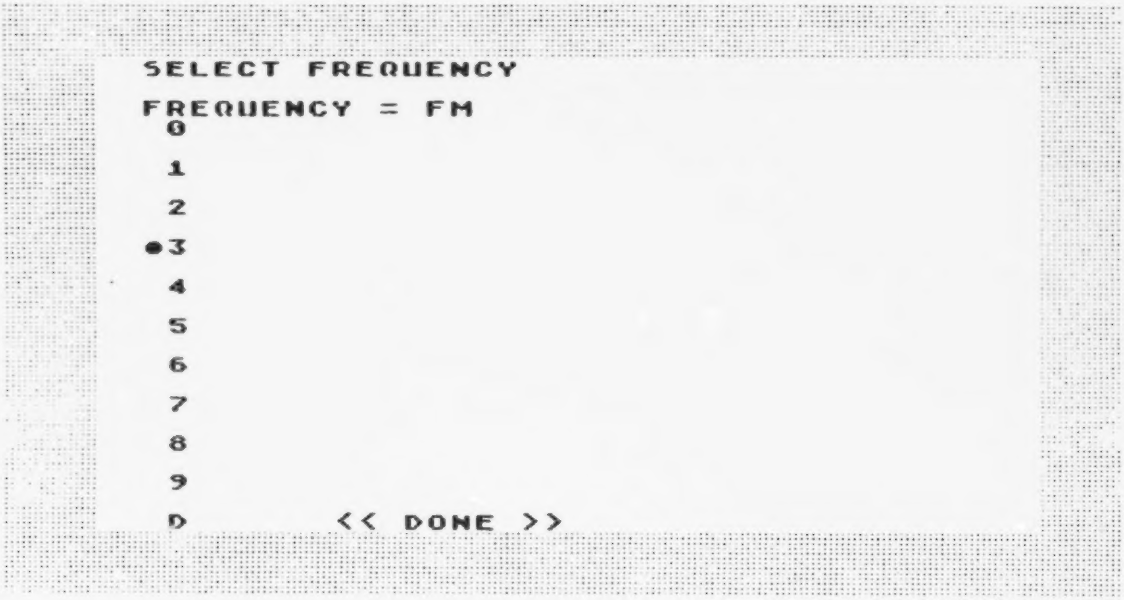
SELECT PRESET CHANNEL NUMBER (0 - 9)

0
1
▸2
3
4
5
6
7
8
9

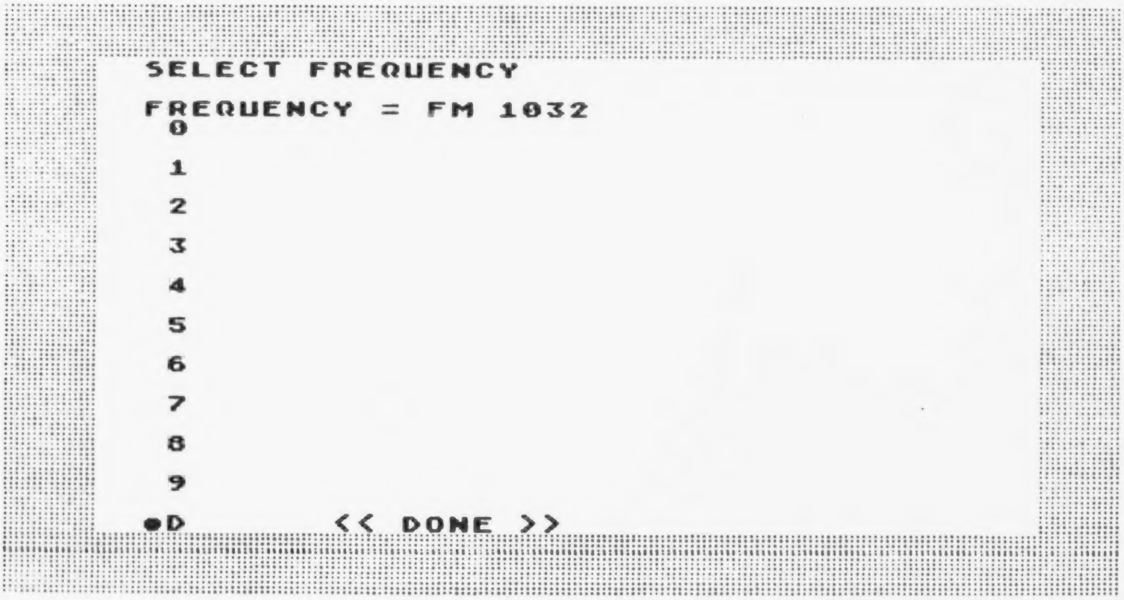


PICK MODE

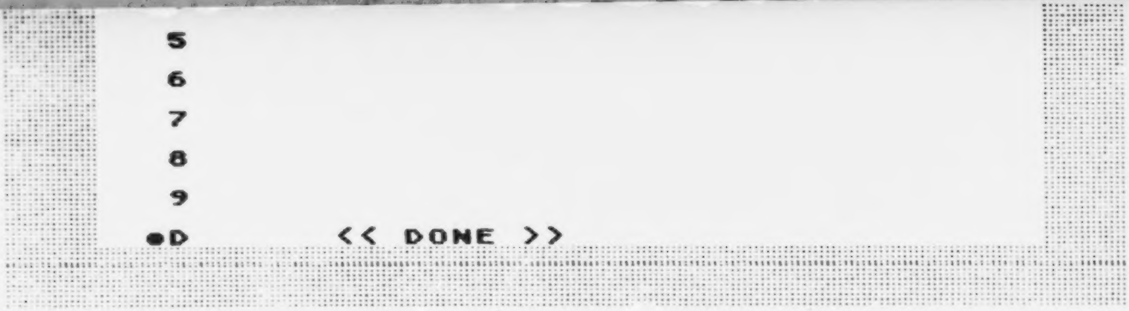
▸AM
FM



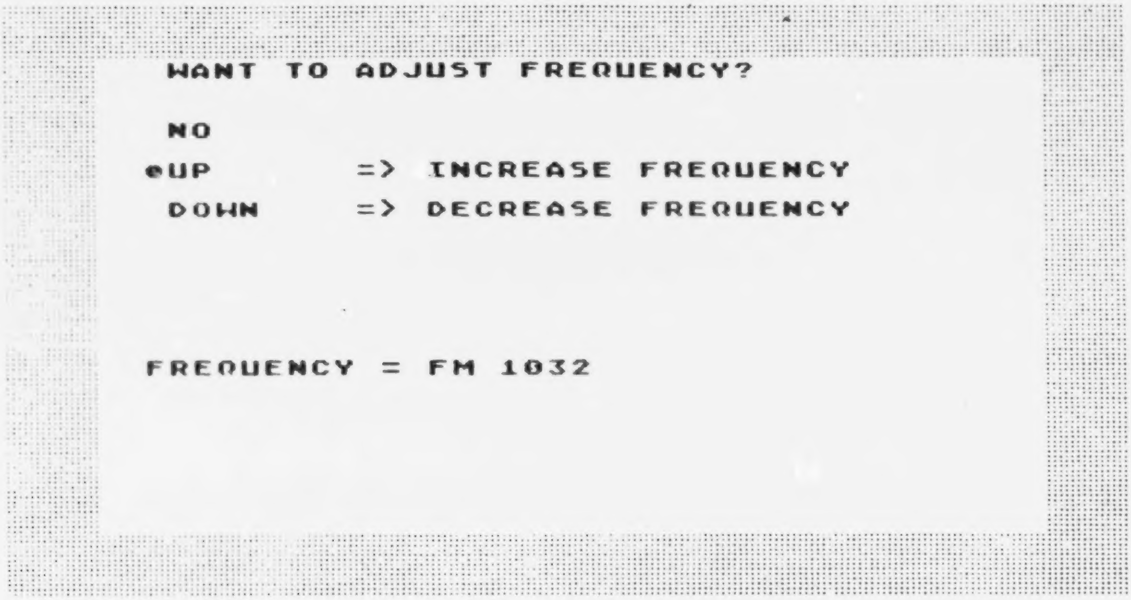
```
SELECT FREQUENCY
FREQUENCY = FM
 0
 1
 2
●3
 4
 5
 6
 7
 8
 9
 D        << DONE >>
```



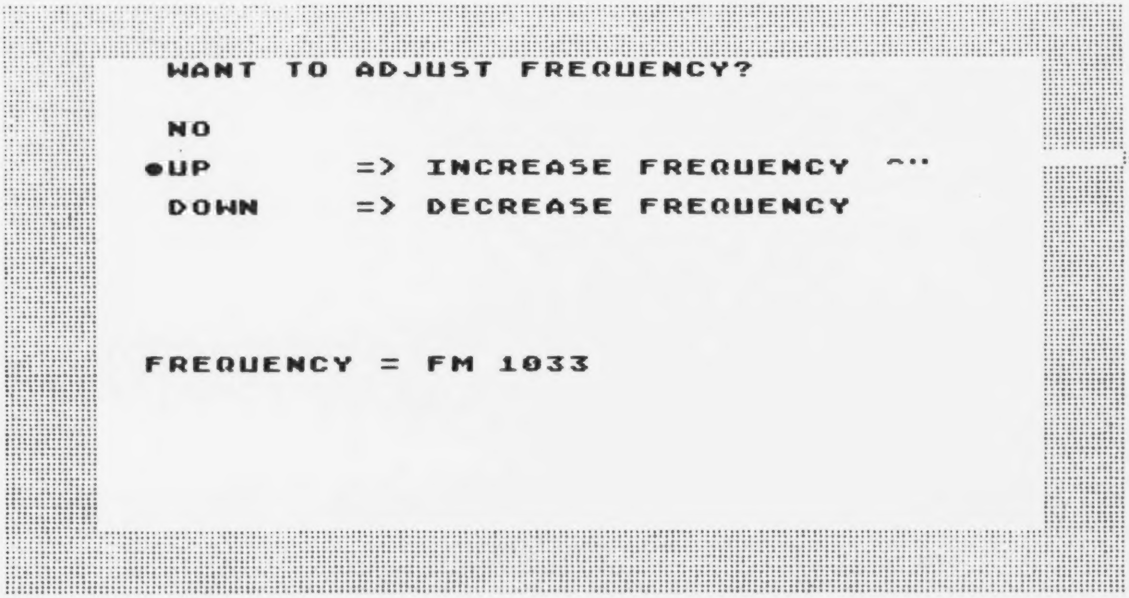
```
SELECT FREQUENCY
FREQUENCY = FM 1032
 0
 1
 2
 3
 4
 5
 6
 7
 8
 9
●D        << DONE >>
```



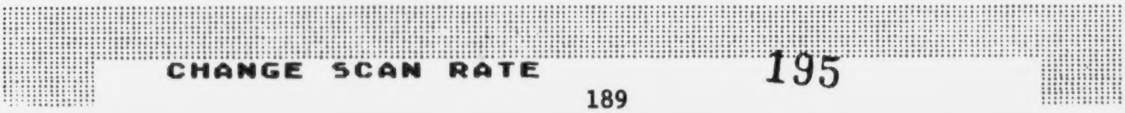
```
 5
 6
 7
 8
 9
●D      << DONE >>
```



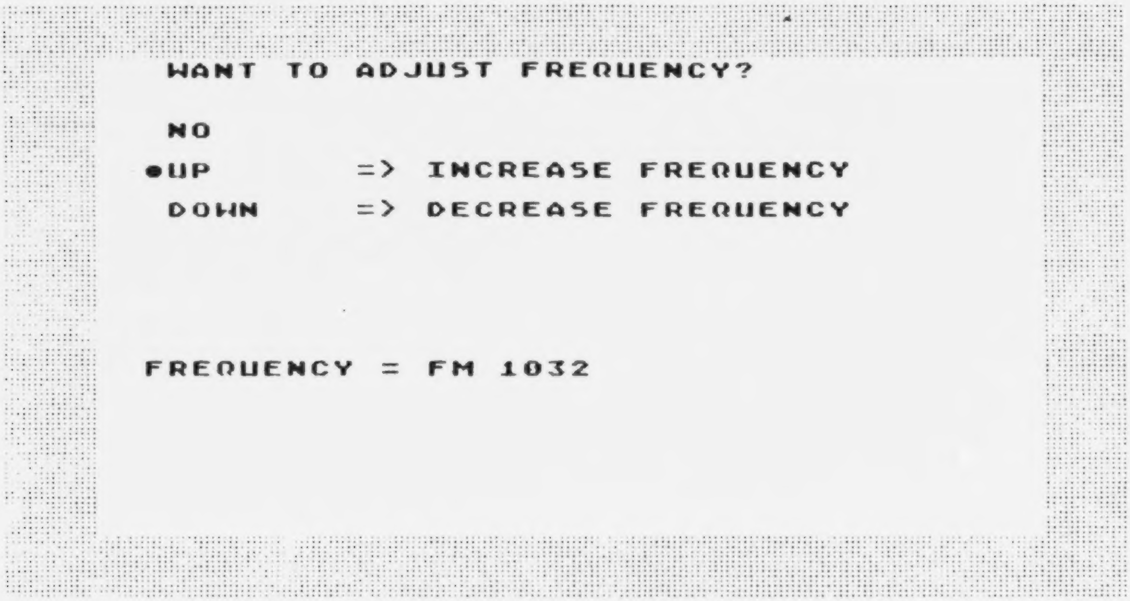
```
 WANT TO ADJUST FREQUENCY?

 NO
●UP        => INCREASE FREQUENCY
 DOWN      => DECREASE FREQUENCY



FREQUENCY = FM 1032
```



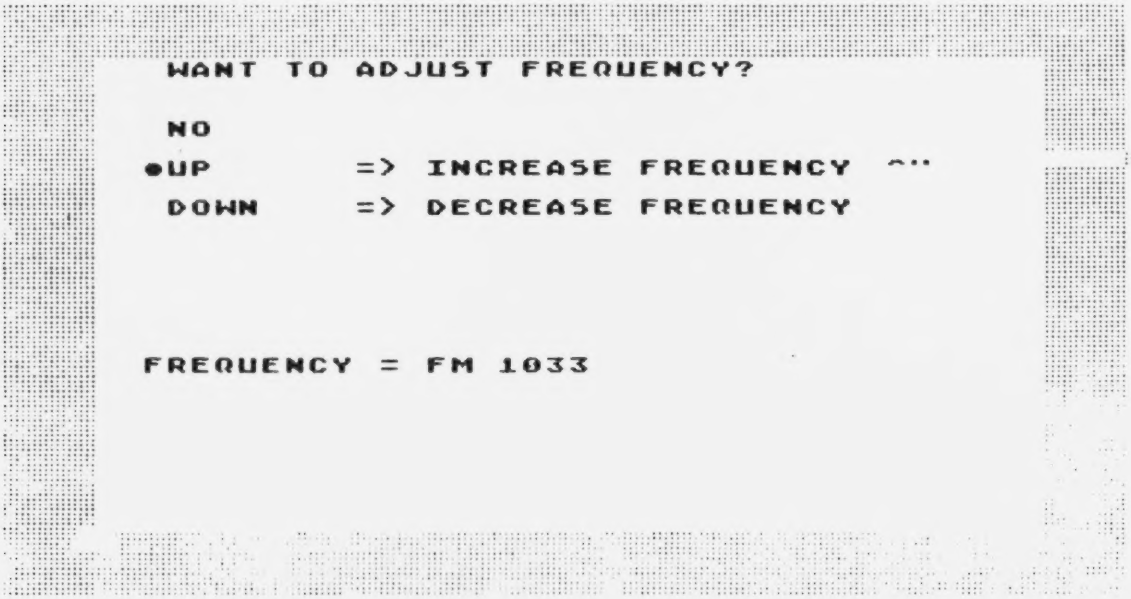
```
 WANT TO ADJUST FREQUENCY?

 NO
●UP        => INCREASE FREQUENCY
 DOWN      => DECREASE FREQUENCY



FREQUENCY = FM 1033
```



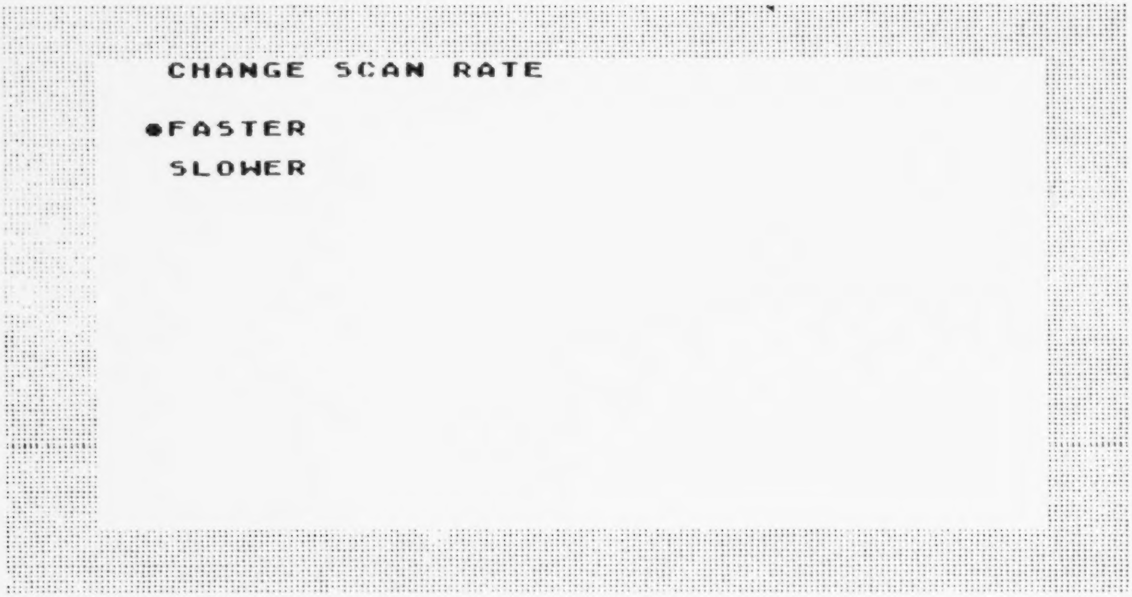
```
 CHANGE SCAN RATE
```



```
WANT TO ADJUST FREQUENCY?

 NO
●UP        => INCREASE FREQUENCY
 DOWN      => DECREASE FREQUENCY



FREQUENCY = FM 1032
```



```
WANT TO ADJUST FREQUENCY?

 NO
●UP        => INCREASE FREQUENCY
 DOWN      => DECREASE FREQUENCY



FREQUENCY = FM 1033
```



CHANGE SCAN RATE

●FASTER

SLOWER

Creative Uses Of Synthetic Speech For The Hearing Impaired

Steven T. Longacre
Los Angeles County Office of Education
Bellflower, CA

The Los Angeles County Office of Education, serves approximately eleven thousand Special Education students among one hundred and ten sites. About half of these students are Special Day students (attending a Special Education program for the majority of their day), while the other half are being served by teachers who are providing designated instructional services. Within the Los Angeles County Schools, there are approximately nine hundred hearing-impaired students.

The author is a Special Education teacher who is credentialed in the area of Communication Handicapped (Deaf and Hard-of-Hearing). He is currently serving as a Teacher on Special Assignment in Microcomputer Education where he inservices and trains special Education teachers throughout the Los Angeles County region on the utilization of microcomputers with exceptional students. He is also a part-time Assistant Professor at California State University, Los Angeles, a microcomputer consultant, and a part-time computer programmer. He was formerly the Coordinator and Consultant of SELACO High School's (Deaf and Hard-of-Hearing program) Microcomputer Lab. The Lab consisted of one (1) TRS-80 Radio Shack 16K Level II microcomputer, seven (7) PET 16K microcomputers, as well as two (2) Apple IIe microcomputers with one of these computers configured with a dual disk drive setup, and a dot-matrix printer. The only additional peripheral for the Apple computer was the ECHO II Speech Synthesizer, which is the focal point of this article.

The ECHO II Speech Synthesizer, manufactured by Street Electronics Corporation in Carpinteria, California, is a package which consists of a small circuit board which can be plugged into any of slots one (1) through seven (7) in the Apple, and an eight (8) ohm speaker that can be secured to the inside of the Apple or used externally. Also included in the package is a diskette with demonstration and utility programs, plus a comprehensive, tutorial-style manual. Besides this package, all the user needs to get started is a 48K Apple II or IIe, a single disk drive, and some creative ideas. While this article focuses on ECHO II's capabilities, one should note that Street Electronics has just released ECHO II+, which has the same options as ECHO II, but also features six channels for music and sound effect generation.

Basically, the system works on a program, provided by Street Electronics, that takes text and generates speech. This program, sometimes known as the text-to-speech mode, contains an algorithm with over four hundred (400) language and pronunciation rules. These rules analyze the text and convert it to basic word sounds (phonemes). Street Electronics has incorporated adjustments for the many irregularities in the English language. As Street Electronics describes it, these sounds are then converted to the linear predictive coding (LPC) parameters needed to control the Texas Instrument's 5220 speech chip. From here, the speech chip generates sounds and passes them through a digital filter. This filter mathematically models the human vocal tract. By changing the LPC parameters for this filter (just as one would change the shape of the mouth and the tongue), different sounds are produced. The final sounds are converted from digital to analog signals, then are amplified and set out through the speaker. The result is remarkably intelligible computer synthesized speech. In fact, if more natural sounding words are desired, Street Electronics has a program called Echo Words which consists of over seven hundred

(700) words and phrases all in a female voice.

This custom mode, as it is sometimes referred to, is possible because individual words have been encoded (not phonemes) into LPC data. This technique captures the fine variances of pitch and rhythm within each word and makes the speech more natural sounding. The drawback to this mode is that you are limited to a fixed set of vocabulary words. However, one can request a customized vocabulary list for use with a particular program one is creating.

Additional features of the ECHO II and Echo Words can be accessed by using simple control commands. Pitch levels vary from low, flat speech to a shrill, piercing voice. Volume may also be set at fifteen different levels. Words in ECHO II can be spoken either monotonically or with intonation. Inflection is added through punctuation characters. For example, a comma will create a pause, a question mark causes a rise in pitch, and a period will result in a drop in pitch at the end of a sentence. The rate of speech can be fast or slow, words can be pronounced in their entirety or spelled letter by letter. The unit also pronounces punctuation characters and numbers. The text-to-speech mode is approximately 90% effective at pronouncing English vocabulary. However, if the refined pronunciation is required, words may be encoded directly at phonemes. The software contains forty-eight (48) phonemes and diphthongs for creating any word or phase. Street Electronics claims that when the various stress levels are employed, almost one hundred (100) different sounds can be produced with rising or falling intonation. To verify this claim, the author has been successful in encoding foreign vocabularies as well as programming

ECHO II to sing, the latter being a favorite of all students who come into contact with ECHO.

Recently, the author had the opportunity to observe this device in action at a computer convention. Aside from being a novelty device for the home computerist, ECHO II had many potential benefits for "hearing" users to enhance existing educational programs. But, by far, this device has far reaching applications for the blind and/or visually-impaired individual as well as non-oral handicapped individuals. The author, who has a severe bilateral hearing loss, was motivated by ECHO II's speech capabilities and consequently was using what residual hearing he had to decipher what ECHO was saying. From this experience, it was not until some weeks later that he realized that this same device could have potential benefits for other hearing-impaired individuals.

The author obtained an ECHO II Speech Synthesizer and immediately began to write programs to be used in conjunction with SELACO High School's Auditory Skills Instructional Planning System (ASIPS). Basically, the ASIPS program encourages and instructs hearing-impaired youngsters how to use their residual hearing more effectively.

All programs that were subsequently written were those that tested students on their ability to recognize the sound of basic letters and numbers and then progressed to basic words and/or phrases. One such program had ECHO II randomly select a letter from the alphabet and say it. The student would then be asked what letter was stated. Another idea generated by the author, was to have ECHO II randomly pick a number, within the parameters set by the teacher, and say the number. Again, the student had to determine what number was given. Letters and/or numbers spoken in isolation proved to be quite difficult (partly due to the synthesized voice), so the author expanded both programs whereby ECHO II would randomly start with a letter or number and randomly say three, four, five or more of them in succession and then stop to ask the student what the next letter or number should be. Options built into both programs allowed students to have ECHO repeat as often as necessary, as well as to work in a drill or test mode. Both programs also provided them the opportunity to see the number signed as well as the letter, word, or phrase fingerspelled graphically on the screen.

Street Electronics has one program on their disk called Spelling Test which the author discovered to have some sound applications. Using another program, List Builder, also provided by Street Electronics, the author was able to input a list of names of those who were employed at the High School. Using the Spelling Test program, ECHO II would randomly say someone's name and then ask the student to give the correct spelling. Here, students were required to give the correct spelling of each person's name. If an incorrect spelling was given or the student did not recognize the name, ECHO II would then proceed to spell the name for the student.

While using the ECHO II with those who had enough hearing to "hear" it, ECHO's speech completely baffled those who could not hear anything at all. Not wanting to leave these individuals out, the author subsequently put the computer in the text-to-speech mode and had these students try to carry a conversation with a hearing individual using ECHO II as the communication source. The deaf student was asked not to sign his question and/or statements but instead, instruct ECHO II to "say it" for him. The hearing individual, upon understanding the question and/or statement, would respond back using Total Communication. The expression on these students was one of amazement, surprise, and excitement realizing that a computer gave them an opportunity to communicate "verbally" with a hearing individual. The author noticed as the students were tying in their questions and/or statements, they stopped and thought about the correct syntax needed to be understood.

As one may begin to see, the potentials of using a speech synthesizer with the hearing-impaired population could have far reaching implications, not only for auditory training purposes, with some limitations, but for improving language skills through simulation type settings. Some students, for the first time, were actually learning about phonemes and language in general as they tried to instruct ECHO II to say a particular word and/or phrase with more clarity.

All the above-mentioned programs were written in Applesoft BASIC and the manual alphabet as well as the number signs were generated with a graphics utility program. While the synthesized speech was difficult for adults and speech pathologists to accept, almost all students who came into contact with ECHO preferred the text-to-speech mode than the custom encoded voice. They were constantly motivated and challenged by the synthesized speech generated by ECHO II. For some students, it was the first time they realized that their hearing aid could actually assist them.

Many software publishing companies are not infusing the capabilities of ECHO II with their programs. Hopefully, many of these programs will allow a feature where text can be turned on or off thus encouraging the user to respond to oral directions only. If this is too difficult, then both text and speech could be generated at the same time.

The focal point of this article was basically to share some innovative ideas but at the same time show what can be done when one "stretches" the so-called limitations of microcomputers. The author has just scratched the surface and is currently working the Apple's Macintosh and a speech synthesis program called Smoothtalker, manufactured by First Byte. The Macintosh, with built-in speech synthesis capabilities, coupled with the program Smoothtalker, produces voice quality that is much better than ECHO's. As with ECHO, Smoothtalker can provide unlimited vocabulary and numerous options, but can also be educated to remember how to say certain words with clarity at all times. With the advancement of speech synthesis and a drop in prices, one will be able to afford such technology and use it to create innovative ideas.

# # #

High Tech For Multihandicapped Individuals

Steven T. Longacre
Los Angeles County Office of Education
Bellflower, CA

This paper will focus on the integration of high technology with multihandicapped individuals within schools and programs being served by the Los Angeles County Office of Education (LACOE). Currently, LACOE serves approximately eleven thousand Special Education students among one hundred and ten sites. About half of these students are Special Day students (attending a Special Education program for the majority of their day), while the other half are being served by teachers who are providing designated instructional services. Approximately two thousand seven hundred of these students are classified as multihandicapped.

The author is a Special Education teacher who is credentialed in the area of Educational Administration as well as Communication Handicapped (Deaf and Hard-of-Hearing). He is currently serving as a Teacher on Special Assignment in Microcomputer Education where he inservices and trains all Special Education teachers throughout the Los Angeles County region on the utilization of microcomputers with exceptional students. He is also a part-time Assistant Professor at California State University, Los Angeles, a microcomputer consultant, and a part-time computer programmer. He was formerly the Coordinator and Consultant of SELACO High School's (Deaf and Hard-of-Hearing program) Microcomputer Lab.

As a microcomputer specialist for special educators, the biggest challenge was convincing those who work with the multihandicapped that these individuals had access to high technology just as any other "special" student did. However, many teachers, parents, and administrators who worked with such students continued to present negative arguments. Some of these arguments are; computers are too complex for their students which will only frustrate them more; students will break high tech equipment; their social skills will be extremely inhibited due to the fact that they are only interacting with machines; there is no appropriate software available for their students; when will teachers have the time to learn to use the computer; and with only one computer the for the entire class, how can the use of the computer be successful?

With all the negative arguments presented, Special Education programs within LACOE are demonstrating that computers can enhance and, in many cases, alleviate these problems areas entirely. However, in order for computers to be successful in any multihandicapped setting computer learning experiences must be integrated into the overall program of instruction. That is, the computer must be treated as a tool for learning and/or as an assistive device which may help an individual to become a productive member of society. In addition, experiences with technological equipment should closely correlate with functional skills that each student is developing. Teachers and students must be given sufficient training in how to operate high tech equipment to become comfortable with it. And, perhaps most importantly, computer software must be well designed and easy to use. Too often, creative and innovative ideas in the use of existing technology is inhibited by the overall disrespect for the role of high technology in our classrooms for the multihandicapped.

Let's look at the negative argument presented earlier and explore some of the strategies being implemented by programs within LACOE multihandicapped classrooms.

The first argument states that computers and technology in general are too complex for multihandicapped students and will only frustrate them more. This statement may have been true ten years ago but with advances in technology and the insistence of the general public for equipment that is easier to operate, we now have access to technology that is no longer for the "technological guru." Because equipment is much easier to use now, frustration levels have dropped dramatically and ease of use has increased. In addition, if proper training and inservicing is provided for those educators who will introduce technology to their students, they will be less intimidated to use such equipment and will then begin to see other creative uses. Some of the equipment currently being utilized within LACOE schools include microcomputers, voice synthesis, voice input, video cassette recorders, video cameras, video digitizers, and a variety of input switching devices adapted to each individual student's needs. In many cases, students only need to respond to a microcomputer through the use of a single switch, thereby reducing the frustration level. Because of this, a special educator who comes into contact with technological equipment should immediately begin to seek out ways in which such equipment can be modified and/or adapted. In doing this, one should not forget to tap into resources that exist within their own community (electricians, programmers, computer hobbyists, etc.). Also, your local electronic store has a lot to offer in terms of building your own adaptive switches, etc., and also at a price that is affordable.

The second argument, students will break high tech equipment, is a valid one and one that all of us should be concerned with. However, there are ways of protecting such equipment while at the same time allowing an individual to have almost complete access. Often, with the use of single switch entry devices, students do not need to have access to the computer keyboard or other equipment if the switch is able to control such devices. Keyguards are available for most keyboards and for those students who drool, covering the keyboard with a simple piece of saran wrap does the job beautifully. But students within LACOE, whether they are multihandicapped or not, have learned to respect high tech equipment and ultimately give it a lot of care. However, this is most evident when the teacher displays the same care. Students initially should be allowed to touch the equipment so that their curiosity level will be diminished to the point that it is not necessary for them to handle and/or touch the equipment in the future.

The third argument is a favorite among those who want out of this field in a hurry. That is, social skills will be extremely inhibited due to the fact that students are only interacting with machines. This is true to some extent, however, the issue here is how one is integrating technology in their classroom. In the beginning, computers were merely electronic workbooks that provided very little if any, human interaction. Educators were using these devices as "babysitters" and spending very little time interacting with the student as he/she progressed through an activity. Educators within LACOE are encouraged to abolish this tactic and instead spend more time with the student at the computer. We also overlook the value in having students work together in teams to solve a particular problem or just to have a discussion about what is going on. In these situations, very critical social skills are being developed and enhanced rather than inhibited.

Argument four, which states that there is no appropriate software available for multihandicapped students, is one argument that still persists today. However, this does not mean that one should give up for this reason alone. With some basic knowledge of programming (or a little help from a computer club), an individual can adapt and/or modify existing public domain programs. In LACOE, we have added speech synthesis to most of our programs and found it to be a definite enhancement to otherwise marginal programs. There are programs available for the multihandicapped population including those not originally intended for them. However, a program by itself is not what makes it successful, it is how the teacher makes best use of it. While some programs may be way beyond the ability of some students, a teacher or his/her aide may be able to take control of the computer (ie. reading of text, inputting answers, etc.) while the student makes all the decisions. Programs found to be most successful in LACOE are those that incorporate at least some of the following components; option for single switch input response, voice synthesis, graphics, color option, and an editor to control pace, reading text level, etc. Programs of this type have a much longer life span than others since the educator has more control.

The next argument, when will teachers have the time to learn to use the computer, is one argument that the Special Education office of LACOE has been very responsive to. From the beginning, it was evident that educators working with the multihandicapped would ultimately come into contact with microcomputers and begin to seek out ways in which they might be of use to their students. LACOE responded by selecting two teachers from each site to be trained as "trainer of trainees."

These individuals, given release time from their classrooms, then had the responsibility of returning to their sites to train others. In addition, a position of a microcomputer specialist was created to assist the trainers and others in the field who needed extra follow up. Without the administrative support that LACOE has provided, teachers would be left on their own to learn about computers and would generally not receive the follow up that is so crucial.

The last argument, asks that with only one computer for the entire class (in many cases, the entire school), how can the use of the computer be successful? As mentioned earlier, many benefits can be derived from group participation and/or discussions. However, in some cases, the direct use of the computer and video equipment by the student has proved to be too difficult or of no practical use. In these situations, educators are using such equipment to enhance their existing curricula. Worksheets, activities, etc. are being created on technological equipment and then utilized with the students. Also, with proper knowledge and awareness of the availability of grants and/or funds that are available for individuals programs, one can certainly increase their inventory of technological equipment.

New instructional strategies and the implementation of high technology within LACOE programs are being introduced almost daily. It is also constantly changing and being revised since we are dealing with each individual student as a special case. When seeking out new methods and/or ideas, we must remember that any idea may be a valid one. If you feel something may not work out, you should try it before giving that idea up. Often, the unexpected result from unusual ideas through experimentation. Our students should always be given first priority and any equipment used directly or indirectly with them, should benefit them first. The word of high technology has a lot to offer the multihandicapped and can certainly lead them to a more independent life. The simple fact that they have some control, whether it is things within their home and/or school environment or playing a simple game, gives them self-confidence that we strive to teach year after year.

# # #

APL: A Language To Assist Disabled People

Donald McIntyre
Pomona College
Claremont, CA

and

R. Ewen McIntyre
Citrus College
Glendora, CA

Introduction

APL is a unique computer language. Unlike any other it was designed first for human thought and only later was it implemented for execution on a computer. Early versions of the language were available only for interactive computing on large computers, and acceptance of APL was hindered because its character set required special equipment. Today APL is readily available on microcomputers (notably STSC's APL*PLUS/PC system on IBM PC and compatibles); the special characters are easily produced either on a graphics screen or by installing a character-generator chip on the monochrome board at a cost of about $25. The Shift and Alternate keys provide a sufficient number of characters on the keyboard, and the characters associated with individual keys can be identified either with a colored card on which every possibility is displayed or by fixing stickers to the keys.

An obvious advantage of APL is the small number of keystrokes needed to produce significant results. Much of the housekeeping characteristic of programming in other languages disappears; for example, the loops and control structures that form so large a part of BASIC, FORTRAN, COBOL, or Pascal programs are usually absent in APL. APL commonly uses less than a tenth of the code required by other languages. Indeed a great deal can be accomplished by simple one-line expressions (so-called throwaway code) without writing programs in the ordinary sense at all.

One of us (D.B.M.) has been involved in using and teaching APL for many years. He has developed a system of APL functions that enable a severely handicapped person to do productive work. We do not use any special equipment.

The other coauthor (R.E.M.), aged 24 and handicapped with cerebral palsy since birth, can type only with the middle finger of the right hand. In June 1982, he was invited by Ms. Florence Cohn to work for her firm, Family Real Estate in Claremont, California. We are grateful for her optimistic assessment and her early recognition that microcomputers can permit a severely disabled person to know the satisfaction of contributing to society by doing a useful job. This coauthor has used our system on an IBM PC for more than three years, producing financial reports for local realtors and mailing lists and other reports for several organizations that aid handicapped people. We use XyWrite (XyQuest, P.O. Box 372, Bedford, MA 01730) for word processing, partly because it interfaces so well with our APL system.

Good examples of the work are the accounting for a condominium association and the financial records for rented houses. The client typically supplies forms on which the various transactions have been recorded, and we use programming techniques that call for the minimum number of keystrokes for data entry; for example, "Weyerhause Mortgage Corporation" can be entered as "we." If several categories have the same initial letters, the computer displays each one and requests the user to make a choice. This also has the advantage of eliminating typographical mistakes either by the client or by the person entering data.

Because the APL system is highly modular, it is rather easy to modify it to meet the changing need of the client. This, of course, would not be possible when using a packaged program.

We wish to demonstrate how raw information received from the client can be entered and turned into useful reports, even by persons who have severe motor disabilities and difficulty with arithmetic. Not only do those physically challenged have the personal dignity of contributing to society, but the program also creates a valuable lesson by offering disabled people experience of the tasks that must be performed to maintain rented houses and by teaching how much it costs to pay for services.

The APL Language and its Implementation

The language takes its name from the title of Dr. K.E. Iverson's book, "A Programming Language," published in 1962 by John Wiley and Sons, Inc. Dr. Iverson, who taught at Harvard before joining the IBM Corporation, recognized the need to extend the familiar set of primitive functions (e.g. + - x -) of mathematics in order to describe processes, such as sorting, that are performed by computers, and even to describe the operation of the hardware itself. One of the early applications of what was then called "Iverson's notation" was the description in 1964 of the workings of IBM's important new line of computers, System/360.

Although the initial use of the notation was for pencil and paper and for the blackboard, it was soon recognized within IBM that the new technology (especially the invention of IBM's Selectric Typewriter) made it possible to implement the notation as a computer language of a spectacularly new kind. This language, originally available at IBM's Thomas J. Watson Research Center, was called APL. Early versions were restrictive, and the significance of APL was overlooked in many data-processing centers. However, IBM made the language available as a commercial product, and several companies went into business to make APL available by timesharing on large computers accessed by remote terminals.

The first microcomputers were not powerful enough to support significant APL implementations; their memories were too limited and their instruction sets did not even include multiplication of integers. APL was, however, implemented on APPLE computers and TRS-80s by 1981. This situation changed dramatically with the announcement of IBM's PC, based on Intel's 8088 processor (and capable of using the 8087 floating-point co-processor). In contrast to earlier microcomputers that typically were limited to 64K memories, the IBM PC's hardware can address a memory of 1 Megabyte.

The version of APL we use is APL*PLUS/PC, available from STSC, Inc., 2115 E. Jefferson Street, Rockville, MD 20852, Tel: (301) 984-5123. This product contains many features that are seldom found on implementations that cost thousands of dollars to lease for use on mainframe computers. STSC also sells a limited, but still powerful version called Pocket APL.

A Simple But Effective Database System

For the records on rented houses or clients provide us with data sheets on which ease transaction is one row. The columns are Month, Day, Category, Property, Check Number, and Amount. This organization was chosen by our clients and we have adapted to it.

A sample database would appear as follows:

	0	1	2	3	4	5
0	10	1	Electrician	634 N Green St	2391	45.93
1	10	1	Plumber	360 W Ninth St	2392	30.00
2	10	2	Trash	123 N College Ave	2393	57.50
3			...	...		

Note that for identification we have numbered the rows and columns, starting with zero. APL provides a symbol for the function of creating a set of index numbers.

```
When you enter:
      ι6

The computer responds:
0 1 2 3 4 5

Other examples are:

      2 = ι6           [where = identifies equalities]
0 0 1 0 0 0

      (ι6) ∊ 1 3 5  [where ∊ is the symbol for membership]
0 1 0 1 0 1

      (~(ι6) ∊ 1 3 5) / ι6   [where / uses the expression
    on its left to select from the expression on its right.
                    The symbol ~  is the logical NOT]
0 2 4
```

Because text is stored in the computer in a different way from numbers, we must represent the Categories and Properties internally by code numbers. This coding and subsequent decoding can be performed automatically by the computer and can be invisible to the user. Let us suppose that the following table represents our database. We will call it D for Database.

```
       D
 7    11    45    53    1037    398.33
 7     8    93    38    1004     75.13
 4    26    52    67    1206    176.18
12    15    68    58    1260     86.65
 6    14    65    41    1188    351.87
 4    27     4    73    1220     23.35
 2     2    36    24    1217    233.61
12    22     7    63    1299    392.89
 1    22    47    23    1266    305.45
 7    24    89    90    1069    181.51
```

Then the following information is available with a small number of keystrokes:

```
      ρD  [the shape of D; i.e. number of rows and columns]
10 6

      1↑ρD   [take the first part of the shape; i.e. number
              of rows]

10
```

```
      1↓ρD   [number of columns]
6

      D[2;4]  [entry indexed at row 2 and column 4,
                  starting with 0]
1206

      D[1 3;]  [rows (i.e. transactions) 1 and 3]
   7       8       93       38     1004       75.13
  12      15       68       58     1260       86.65

       D[;5]   [column 5, i.e. amounts]
398.33 75.13 176.18 86.65 351.87 23.35 233.61 392.89 305.45
181.51

      D[ι4;]   [first 4 rows]
   7      11       45       53     1037      398.33
   7       8       93       38     1004       75.13
   4      26       52       67     1206      176.18
  12      15       68       58     1260       86.65

      4 6 ↑ D  [takes the first 4 rows and all 6 columns;
                and hence gives the same result as above]

      ¯4 6↑D   [takes the last 4 rows and all 6 columns]
   2       2       36       24     1217      233.61
  12      22        7       63     1299      392.89
   1      22       47       23     1266      305.45
   7      24       89       90     1069      181.51

      +/D   [sum all the rows;  in this case it doesn't
make sense to sum the rows, but in other tables it may do]
1551.33 1225.13 1531.18 1499.65 1665.87 1351.35 1514.61
1795.89 1664.45 1460.51

      +⌿D   [sum all columns;  in this case it doesn't make
sense to sum any column except the last one, the amounts]
62 171 506 530 11766 2224.97

      +/D[;5]  [sum the amounts in column indexed 5]
2224.97

      (D[;0]=7)⌿D  [select the July transactions]
   7      11       45       53     1037      398.33
   7       8       93       38     1004       75.13
   7      24       89       90     1069      181.51

      X←D[⍋D[;1];]  [create a new database X sorted by day]

      X←X[⍋X[;0];]     [now sort database X by month]
      X                  [display the sorted database X]
 1      22      47       23     1266      305.45
 2       2      36       24     1217      233.61
 4      26      52       67     1206      176.18
 4      27       4       73     1220       23.35
 6      14      65       41     1188      351.87
 7       8      93       38     1004       75.13
 7      11      45       53     1037      398.33
 7      24      89       90     1069      181.51
12      15      68       58     1260       86.65
12      22       7       63     1299      392.89


      X[;5]⍳398.33   [find the row index of amount $398.33]
6

      X[6;]                      [display this transaction]
7 11 45 53 1037 398.33

      X[6;5] ← 389.33            [change the amount]

      X[6;]                 [display the edited transaction]
7 11 45 53 1037 389.33

      (~(⍳1↑⍴X) ∊ 1 3 7)⌿X   [take all rows that are NOT
                                1 3 or 7]
    1       22      47       23     1266      305.45
    4       26      52       67     1206      176.18
    6       14      65       41     1188      351.87
    7        8      93       38     1004       75.13
    7       11      45       53     1037      389.33
   12       15      68       58     1260       86.65
   12       22       7       63     1299      392.89
```

In order to achieve consistency we must introduce a Controlled Vocabulary, for which we use the mnemonic name CVOC. Only categories and properties that appear in this list are allowed. This is necessary so that in monthly and annual summaries we will not have categories such as "Custodial" and "Janitorial" appearing as separate items when they actually refer to the same one. We help the client prepare this list and APL*PLUS/PC's a full-screen editor makes it easy to enter the information. Here is a sample:

```
           CVOC          [Display the Controlled Vocabulary]
Plumber
Weyerhauser
Electrician
625 West Twelfth Street, Claremont
```

The following expression asks for text input, and determines which items in CVOC match it. The input is usually shorter than item we are searching for, and the length of the input is the user's choice.

```
        U ← CVOC[;⍳⍴S] ^.= S ← ⍞
We                           [this is our input]

        U                    [display U]
0 1 0 0                      [it identifies the matched category]

        U⌿CVOC          [use U to select the matched category]
Weyerhauser Mortgage Corporation
```

The symbols ^.= illustrate a powerful feature of the APL language, the details of which we cannot enter into here. We can only say that ^ represents the logical AND, and the operation ^.= checks whether or not it is true that each character in a given row of CVOC matches the corresponding character of the string S that was input when ⍞ was executed by the computer.

The following is a simple, but complete computer program that can be used to input the raw data received from the client and create a database in which categories and properties are identified automatically by their row index numbers in the controlled vocabulary table.

```
[0]    IN
[1]    D← 0 6 ⍴0
[2]   START:'Continue?  y or n'
[3]    →('y'≠⍞)/0
[4]    'Date:  MM DD'  ⋄  Z←⎕
[5]    'Category'
[6]    U←CVOC[;⍳⍴X]^.=X←⍞
[7]    Z←Z,U⍳1
[8]    'Property'
[9]    U←CVOC[;⍳⍴X]^.=X←⍞
[10]   Z←Z,U⍳1
[11]   'Check #' ⋄  Z←Z,⎕
[12]   'Amount'  ⋄  Z←Z,⎕
[13]   D←D⍪Z
[14]   →START
```

The database that is created when this program is used can be printed out by the following program, which translates the coded numbers for categories and properties into their full text form.

```
[0]    OUT D
[1]   START:→(0=1↑⍴D)/0
[2]    X←D[0;]
[3]    (⍕2↑X),(,CVOC[2↑2↓X;]),⍕¯2↑X
[4]    D←1 0↓D
[5]    →START
```

In order to output both text and numbers on a single line, it is necessary to convert the numbers into their character presentation. This is somewhat similar to the formatting required in other languages, such as FORTRAN, but in APL it is much easier. The symbol xx instructs the computer to make the conversion.

Making the Operation Easier for the User

To send output to the printer under DOS (IBM PC's usual operating system), one must press two keys simultaneously. Because this may be difficult or impossible for a physically disabled person, we can create the following print module that can appear anywhere in a larger program:

```
[0]     PMSG
[1]     'Printed report?  y or n'
[2]     →(~⎕INKEY∊'Yy')/0
[3]     X←1 ⎕POKE 116
```

⎕INKEY accepts one character of input without use of the Return key. ⎕POKE generates a machine instruction that sends subsequent output to the printer. A similar module turns the printer off.

Because it is likewise awkward to make the first character upper case when entering a category, the following module will automatically ensure that the first character is converted to upper case from lower:

```
[0]     Z←UFL S
[1]     Z←S
[2]     →(~S[0]∊'abcdef ...  xyz')/0
[3]     Z[0]←⎕AV[¯32+⎕AV⍳S[0]]
```

XAV is the "atomic vector," or list of all 256 possible characters that can be stored in the machine. Lower case "a" is at position 97 in this list and upper case "A" is at position 65. Consequently, if we subtract 32 from the index of a lower case letter we will get the index of the corresponding upper case letter.

APL*PLUS/PC provides tools for ensuring the validity of entered data. For example to check whether text has been entered when numbers were expected, whether improper numbers, such as 1.2.3 have been entered, or whether the wrong number of numbers has been entered. The simple program IN does not use any error checking, and it has only primitive features for convenience of entering data, but the programs we use every day make full use of APL's ability to detect errors and allow immediate recovery.

Similarly the demonstration program OUT has the minimum of editing built into it. In practice we use APL's powerful means of editing output. The date, for example, can easily be displayed as 10/19 than 10 19, and negative balances are output in the form <$123.45>.

APL*PLUS/PC has full capability of defining and controlling windows; the screen can be subdivided into small virtual screens of shape and size determined by the user. Full-screen menus can be displayed very fast, and input can be performed on a screen that looks like a form on which the blanks are to be filled in. Editing of previous entries is done in exactly the same way; the form is displayed with the old data filled in, and the user can choose which entries to change.

APL contains powerful means of performing mathematical functions. For instance a program to compute the table of payments and interest on a loan with a declining balance can be written in a single line. We use this when a realtor needs to know what the balance will be after a certain time has elapsed. Functions more complex than any that Lotus 1-2-3 can perform can be executed in an APL expression of a single line.

As voluntary work, we regularly print mailing labels for organizations that help the handicapped, for example, Therapeutic Equestrians and SCIL , the Services Center for Independent Living, an office for advocacy and support for disabled people in the Pomona Valley. Our programs are all written in APL and most of them are incredibly simple. For example we recently merged eight separate lists of names in order to eliminate duplicates and provide a single master list. Suppose we have two lists, A and B, with 456 and 201 rows, respectively, and each with 25 columns. Then the following steps are all that are needed to provide a single, alphabetized master list in which the source, A or B, is identified for each name:

```
M←(A,'A')⍪B,'B'   ⋄      M←M[alph⍋M;]
```

where alph defines the collating sequence to be used.

Such an operation is so simple that it can be performed without writing a program at all. A few keystrokes do the job.

APL*PLUS/PC provides the same facilities for reading and writing files on disk that are used on the largest computers. Even ASCII files written by word processor or other software can be read or written from APL by simple statements. We use this feature to keep our data on the disk separately from the APL programs. Moreover, a so-called "latent expression" (defined by the APL system function XLX) permits the data to be recalled automatically from the disk as soon as the APL workspace is loaded. The same mechanism can also place the menu of options on the screen as soon as the computer is switched on. The menu would display such choices as:

1. Input new data
2. Print copy for proof reading
3. Edit data already entered
4. Print report on all properties
5. Print report on a single house
6. Print current balances
7. Utilities
8. Save data on disk and end this session

A variant of the latent expression is the "error latent expression," XLEX. This provides for some process to occur automatically as soon as an error is detected by the system. Although we build our own error-checking routines into our programs, the unexpected sometimes occurs. It is then important for the programmer to know what happened. We use the "error latent expression" to create a file on disk that contains all available information of the state of the machine when the error occurred. APL has the ability to record the date and time, the nature of the error, and the instruction that was being performed when the error was detected. Of course, we also save on the disk all data in the computer's memory, so that none of the user's effort is wasted.

Telephone Communication

We use a system written by us in APL to communicate with remote mainframe computers. These include Western Union's Easy Link system, DIALOG's bibliographic databases, and Bank of America's Homebaking. A disabled person can pay checks, move money between checking and savings accounts, and obtain a bank statement at any time. Some of these services are free, others are costly, but all can be obtained with an almost push-button operation.

Applications

The following list summarizes the current applications of the system described above:

1. Financial reports on rented houses
2. Condominium Association accounts
3. Finances of a business building with rented suites
4. Realtors' expense accounts
5. Payment schedules on loans
6. Mailing labels
7. Newsletters using XyWrite as a word processor
8. Homebanking

We foresee that with the necessary financial report, including IBM PCs, a small business in a professional office setting employing several handicapped people should be established soon in the Pomona Valley. Those running the business should be able to read a a minimum of 6th grade level, and should be trained to be conscientious and accurate in what they do, and not become jaded with routine work. For such physically challenged people absolutely no employment opportunities exist in the area. With the help of an office manager and a courier, an effective, sought-after, and profitable service could be available to many businesses and organizations. With three years of successful experience behind us, we believe that the future holds promise of exciting developments.

# # #

Computerized Symbol Processing For Handicapped Persons

Russell T. Osguthorpe
Linda Li Chang
Scott B. Mitchell
Brigham Young University
Provo, Utah

Several research studies have documented the benefits of using alternate symbol systems, such as Rebus and Blissymbolics, with persons who have severe communication disorders (Carrier, 1974; Clark, 1981; 1984; Sailor & Guess, 1983). These logographic symbol systems have increased in usage so much in recent years that some believe that they will soon be as common as manual signing for nonspeaking severely handicapped individuals (Clark, 1984). However, while the popularity of symbol systems is increasing, handicapped persons still have no way of using the systems to produce written communication. Like sign language, logographic symbols are strictly transitory, providing users with the ability to express themselves, but no with the ability to preserve their communications.

But what if a computerized system were developed which would allow users to create communication electronically, much the same as nonhandicapped people user word processors? Such a system would need to be easy to operate, flexible (allowing users to print their communications in English or in the picture symbols), and low in cost. The system obviously would need to include an alternative to the traditional computer keyboard which requires too much motor control to be of value to most Rebus and Bliss users.

Although several adaptive keyboard devices have been developed, each one has certain characteristics which make the device less than ideal for severely and multiply handicapped users. Peripherals presently on the market are either very limited in the types and numbers of available symbols, are inflexible as to the size of each symbol, are difficult to operate, or are prohibitive in cost (Osguthorpe, Li & Applegate, 1985). Due to these findings, a project was launched to develop a symbol processing system that would be more flexible and cost-effective than those presently available. The purpose of this article is to describe a study in which a newly developed system was evaluated. Because of the newness of the system, the study was formative in nature, focusing on the useability of the system and the uniqueness of each user's performance.

Method

Development of the Computerized System

Two different types of peripherals for the Apple II computer have been used in the symbol processing research. In the initial stages of the project, an Apple Graphics Tablet, measuring 11 inches square was used. Software was written allowing the user to select from among 110 (one inch square) Bliss symbols from the board by touching an electronic pen to the tablet. A plastic overlay was placed on the tablet to show the location of each symbol. During the initial experimentation with this system, the user could print out communications on a Prowriter printer, but only in the symbols themselves, English equivalents had not yet been added to the software.

Later in the project the software was expanded to include either Rebus or Bliss symbols and the English equivalents of those symbols. This allowed the user to print out communications in either English or in the symbols, depending upon the intended receiver. In addition, a new type of communication board was used which allowed users to activate the computer by touching the board with their finger, rather than with the electronic pen. This peripheral, called the Power Pad, provided a similar size of activating area, but was much less expensive than the Graphics Tablet. Figure 1 shows the hardware configuration using either the Power Pad or the Graphics Tablet.

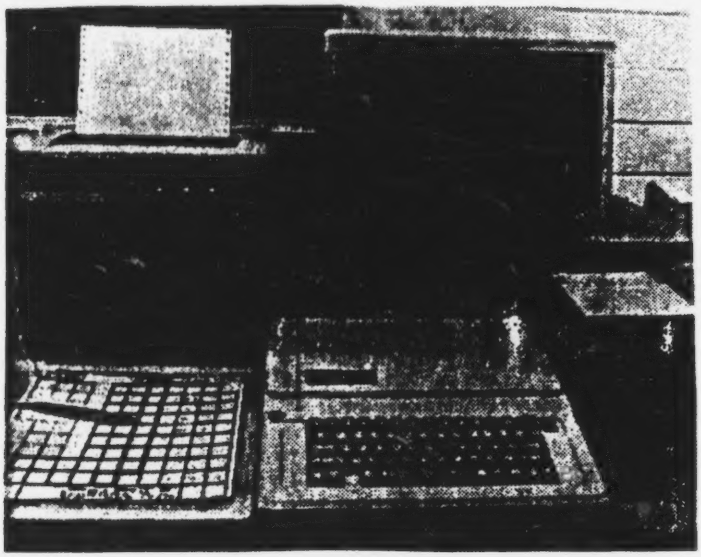


FIGURE 1 The hardware configuration of the System Processors.

Continual refinements are being made in the software to allow users to customize their computer boards more easily, making the resulting board as much as possible like the regular one they normally use.

Pilot Study

Prior to conducting the current study, a two week pilot project was launched to investigate the effectiveness of the Apple Graphics Tablet configuration with Bliss users. The study involved 10 severely and multiply handicapped residents at a state residential facility for the mentally retarded. The results of this initial study indicated that after only 2 hours of practice severely disabled nonspeaking individuals:

1) were able to produce understandable communications using the computerized system,
2) improved significantly both their accuracy and speed in using the computerized board,
3) had a positive attitude toward using the system, but
4) had difficulty using the electronic pen attached to the tablet.

Rebus Symbol Study

In the second study Rebus symbols were used rather than Bliss symbols and the Power Pad peripheral was included with the Apple Graphics Tablet for comparison purposes.

Method

Setting

The second study was conducted at a self-contained day school for the mentally handicapped. The school enrolls approximately 100 students, ages 5 to 21 who have been recommended by parents and school personnel for placement in a full-time special education setting. The school serves the needs of students with moderate to profound retardation, with many of the students having additional handicapping conditions. While all of the students live at home, the severity of handicapping conditions is similar to that of residential students prior to the mainstreaming movement.

Students

A total of 12 moderate to profoundly retarded students, ages 7 to 16, participated in this study. Each student was referred by a homeroom teacher as someone who might benefit from training in symbol processing. Of the 12 students, 6 did not use intelligible speech; 2 used extremely limited speech, 3 had two or three-word-phrase and 1 had 9 or 10 word sentence expression. Their experience with Rebus symbols ranged from 0 to 50 symbols. With regard to their motor control, 3 had cerebral palsy and 3 used a wheelchair. Among the 12 subjects, 4 had very poor or poor gross or fine motor control but could point with their fist or finger; 1 had limited motor control, 4 had fair gross and fine motor control and 3 had good fine and gross motor ability.

System Implementation

In order to measure the relative merits of both the Graphics Tablet and the Power Pad systems, two groups of handicapped users were formed. To control for nonequivalency between the two groups, both systems were used by both groups. During the first 7 weeks of the project, Group I used the Graphics Tablet and Group II used the Power Pad. During the final two week period, the groups exchanged communication boards.

For the first 6 weeks, each child spent an average of 20 minutes each session 3 times a week to work on the Symbol Processor system. At least twice a week the children were encouraged to write what they felt and thought to whomever they wished to write. After introducing the system to the users, each student received two or three training sessions individually prior to the free-expression writing. During the training the proctor vocalized the symbols row by row to enhance students' understanding of each symbol.

Students were tested on their speed and accuracy in mastering the Rebus symbols and using the board during the third session of each week. During the tests, the proctor arranged flash cards into meaningful sentences and showed them to students. Each flash card has a Rebus symbol and its corresponding English word. After each student composed these sentences by pressing the appropriate symbols on the board, the student's time and error rate were recorded. The fixed sentences in Test A had 10 Rebus symbols which were "Hello I ride bus. I like [to] see television." Test B had 25-symbol sentences which were "Yes give me money. I want big ice-cream and cookie. I like my mother. I want [to] kiss my father and mother."

The students used the system more frequently during the last three weeks -- as often as four or five times a week to determine if they might lose interest from intensive involvement with the system.

Parent/Teacher Questionnaires

At the conclusion of the study, the 5 teachers whose students participated in the study provided feedback to project staff by filling out a questionnaire. The questionnaire asked for teachers' perceptions regarding the effects of the symbol processing program on each student. The same questionnaire with slight modifications was presented to the parents or guardians through telephone interviews.

Results

In this section of the article a description will first be given of how the two groups performed on each of the symbol processors. Results from the parent and teacher questionnaires will then be discussed. Because each student possessed such a unique array of personal characteristics, more detailed case descriptions will be given of selected students from each group.

Group Performance

Figures 2 & 3 show how each group improved in both speed and accuracy on each of the two boards. Of special interest is the ease with which students adjusted to the other board

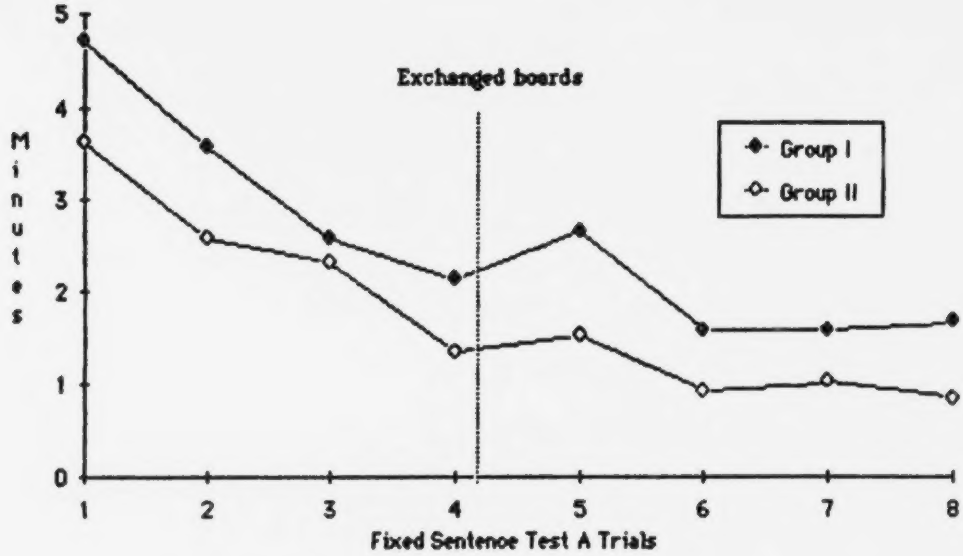


FIGURE 2 The speed of each group using both boards.

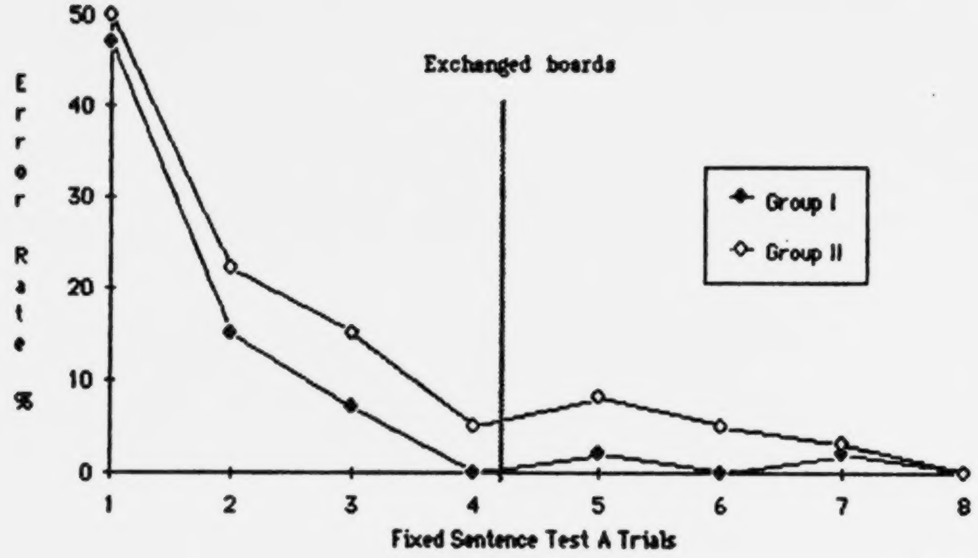


FIGURE 3 The error rate of each group using both boards.

When the exchange was made. As seen in Figures 2 & 3, rather than hampering student performance, the introduction of a different symbol board actually improved both speed and accuracy for most students, regardless of which board came first. During the first set of trials, Group I tended to perform more accurately than Group II, yet took longer to complete the task than Group II. However, when changing to the second board, both groups became more similar in speed and accuracy. For instance, Group I achieved a 2% error rate on the third trial, while Group II had an average error rate of 3%. During the fourth trial, both groups performed virtually error free.

All subjects showed great enthusiasm during free expression trials. Students commonly did not want to quit and would go beyond their scheduled time. Most of them made understandable expressions after a few sessions of practice. The content of their writing varied, including mention of family, friends, food, clothes, TV, swimming, riding the bus, pets, their wheelchair, and personal activities.

Teachers' Questionnaire

All teachers said that the system was beneficial to their students, mentioning the following effects: increased self-confidence, self-esteem and self-image, improved use of symbols, and the improved communication skills. They suggested that the nonvocal, the socially reserved, and the students with limited writing skills gained most from the system.

All five teachers said that their students retained high interest in the symbol processors. The most frequent comments included: "The student always seemed to be excited, when it was time to work with the computer," "The students took greater pride in their work and shared their work with classmates;" "They [the students] always wanted to show their printouts to me [the teacher] and point each symbol." Four out of five teachers would like to see the project continue next year. One did not respond to this question. However, they all believed that the system could, in the long term, be beneficial to students. When asked to cite specific benefits of symbol processing, teachers said that they believed that it helped students organize their thoughts better, communicate more effectively with others, improve their writing skills, and become generally more expressive.

None of the five teachers responded with negative comments regarding the effects of the symbol processing experience on their students.

Telephone Interviews with Parents

A total of 11 of the 12 parents were interviewed by telephone regarding their perceptions of the program for their child. All 11 parents' responded as positively as the teachers'. They supported the project and all wanted to see it continue during the next school year. When asked to cite specific benefits that they believed their child had received from the program, they mentioned most often improved communication skills and personal attitudes. Included in their comments were: "better eye-hand coordination, more expressiveness, making more complete sentences, organizing thoughts and writing them down, learning symbols well, using the overlay at home independently, and trying to vocalize words more." Parents mentioned further improvements in "self-confidence, attentiveness, enthusiasm about work and pride in their letters from the computer."

Case Studies

In order to give a more detailed description of the results from the study, three representative case studies will be given. In order to protect the identity of the students, their names have been changed in this article.

Case 1. Edward (in Group I) is mentally handicapped 13-year old boy with cerebral palsy primarily affecting his left side. In spite of his handicaps, he is able to run and play actively with the other children, although he rarely uses his left hand due to his motor disability. Edward is categorized as severely multiply handicapped, is basically nonvocal, but knows about 50 signs such as "mother, baby, toilet, yes and no." He writes very little, but uses a Rebus communication board made by the speech therapist who estimated that he knew at least 25 symbols before the study. Edward gestures, grunts, and sometimes laughs inappropriately according to his teacher report. He understands most directions in class, but can be quite stubborn at times.

During the training sessions Edward would often touch the proctor's shoulder or skirt as if he liked the color or pattern in the material, clap his hands and nod his head. Sometimes he would run straight to the computer room, once his teacher permitted him to leave the classroom. When asked to practice on the computer during his recess, Edward would drop from his swing or slide down the slide and run immediately into the building. It was easy to feel his excitement about coming to the computer room.

Edward made rapid progress in his ability to use both communication boards. Figures 4 & 5 show how Edward, when using the Graphics Tablet, was able to produce the fixed sentences in

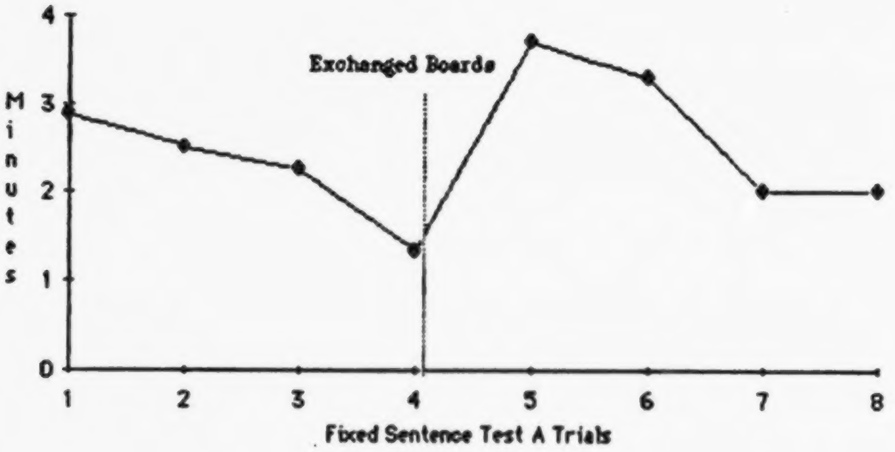


FIGURE 4 Edward's speed using both boards.

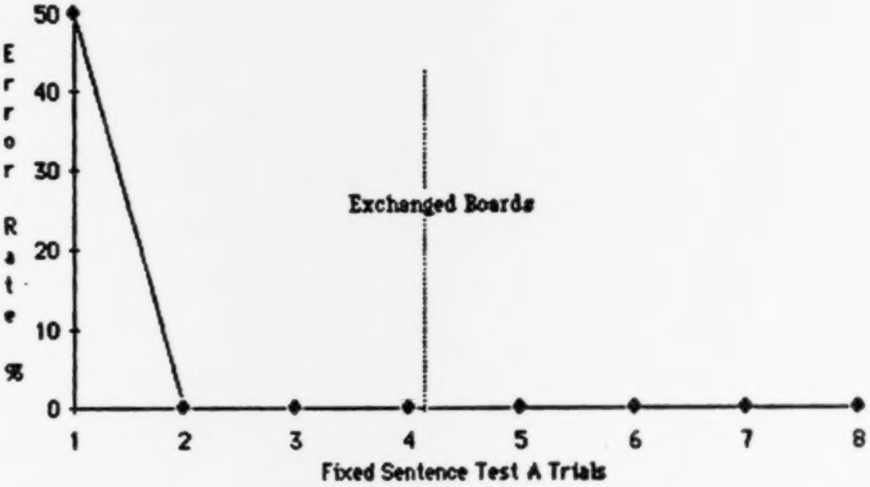


FIGURE 5 Edward's error rate using both boards.

less than half the time after only four trials. Later, when he used the Power Pad, he obtained similar results, reducing his initial speed from 3 minutes, 42 seconds, to 2 minutes on the fourth trial. He seemed to show slightly faster speed when using the Graphics Tablet than when using the Power Pad, but the differences were not large. His accuracy on both boards was excellent. Only on the first trial (with the Graphics Tablets) did he made substantive errors. When changing to the Power Pad, he immediately responded with the same degree of near perfect accuracy.

While working on the computer, Edward typically clapped his hands and laughed. At the beginning of each session, he would usually press the board randomly and would then become extremely excited about pressing numbers, and the words: "go," "up" and "bus." He soon was fascinated by the function of the erase key. He would press any group of symbols and then use the back-arrow and erase them one by one. As he watched the symbols disappear from the screen from the screen after pressing the erase key, he would become extremely excited and begin clapping his hands crazily.

At times Edward was easily distracted from the symbol processing task. It was at these moments that it became difficult to understand what he meant by the symbols he pressed. For the first three weeks he just made random selections of symbols with segments of phrases such as "play ball" and "bus to ride in."

On one occasion, Edward was asked to write about his activities after school. He wrote the following in five minutes, "I go my house. I like bus to ride. My teacher hello with me. I see TV TV in my house." Riding a bus and swimming seemed to be the focus on his daily activities. During a later session, Edward spent over eight minutes composing a 32-word letter. He wrote about playing ball with an animal, swimming with boys and girls, music, his parents eating cookies and his enjoyment of books. During this session his ability to focus on the task seemed especially keen.

Observation of each student's performance indicated that each user of the Symbol Processor seemed to view the function or purpose of using the system differently. Some had greater needs to express themselves and were more serious about writing down their inner feelings; while others seemed to view the task more like a computer arcade game. Edward often portrayed the more playful, gaming attitude, while David, presented in the next case description, displayed an attitude that was more intense and communicative.

Case 2. David is a moderately retarded eleven-year-old boy with good motor and fair fine motor control. His favorite sport is basketball. He was in Group II and, therefore, started with the Power Pad and then switched to the Graphics Tablet. David has little speech, but signs very well, and does at times speak in 4-word sentences. He is learning to write his name, but is unable to write other words or sentences. Prior to the study, his teacher reported that he did not know any Rebus symbols. One of David's strengths is his ability to interact socially. He enjoys teasing other students and teachers and making them laugh. His ability to follow directions is also more well developed than some of the other participants in the study.

When David first attempted to use the Power Pad, he quickly learned the meaning of the symbols and showed excitement when he was able to recognize them. He was especially happy each time the big smiling face appeared on the screen as the computer was loading a file. It was at these early moments that he became the most distractible and playful. When entering symbols, he could use either his left or right hands interchangeably. He intended to look at the screen very closely when his letter was printed, and touched the screen to point to each symbol.

Not only did David make tremendous progress in speed and accuracy (See Figures 6 & 7),

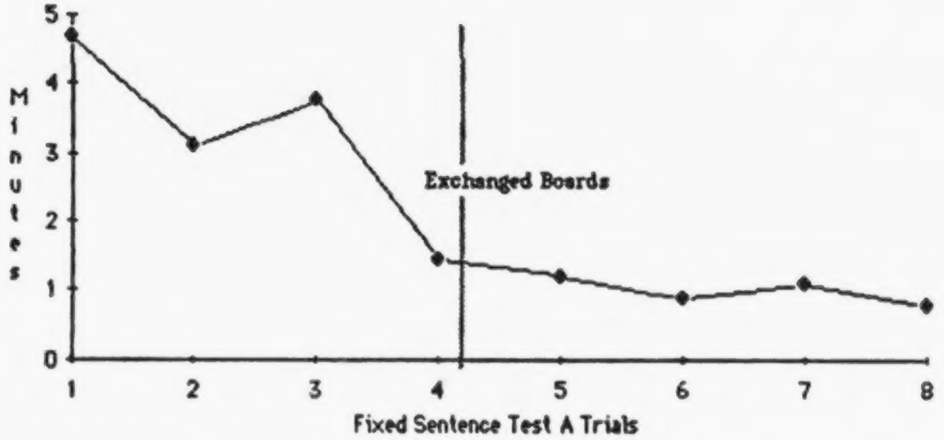


FIGURE 6 David's speed using both boards.

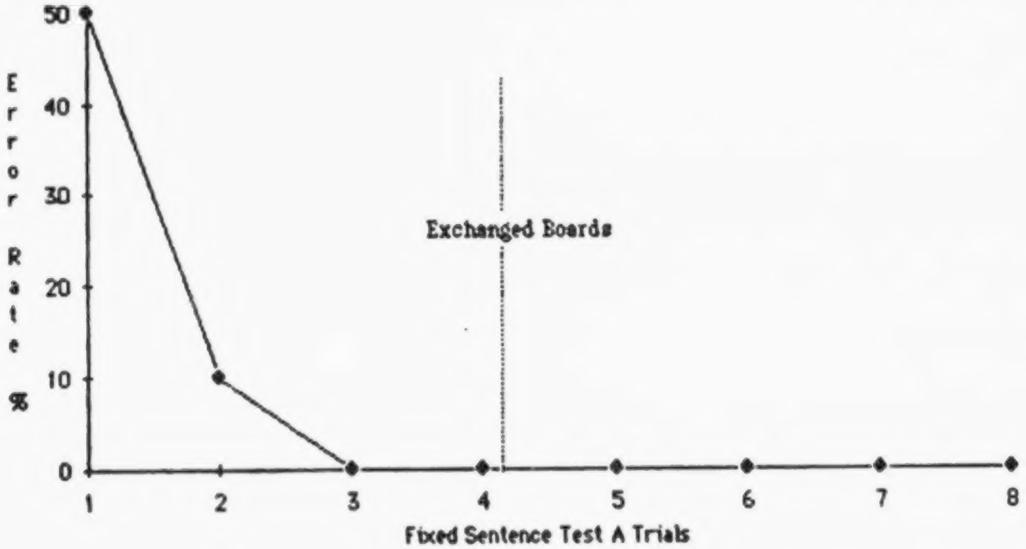


FIGURE 7 David's error rate using both boards.

he also composed 19 understandable entries out of 22 free-expression trials. On one occasion he wrote, "I watch TV with my family. I go toilet in my house. I ride bus bus." He was laughing all the time while writing this message. Like other users, David wrote often about his desires, one day writing a letter indicating his desire to read books; another time writing, "I want milk milk. I want to see TV. I want to ride bus bus."

Near the end of the study, for the first time, David wrote about his feelings toward his girl friend. He said, "I like my girl friend. I want to call girl. I want to kiss my girl friend." (See Figure 8) He wrote this 18-word letter in less than three minutes (2'58") using his left and right hands

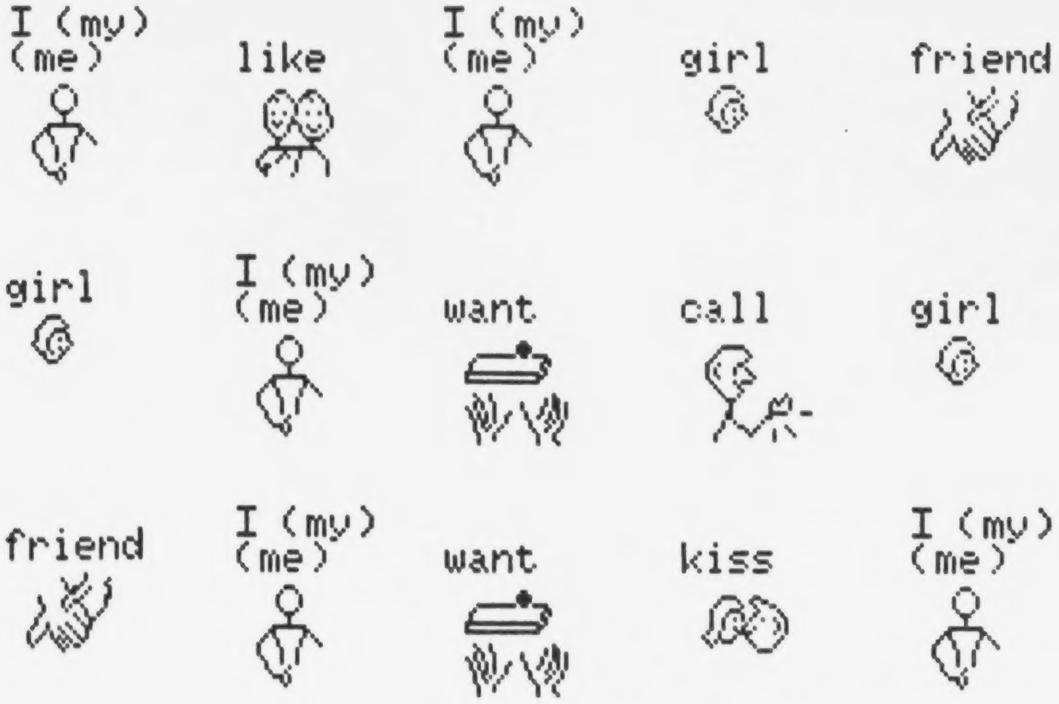


__FIGURE 8__ A sample of David's writing.

interchangeably. It was fascinating to observe his efficiency in using the system to express himself.

David's genuine interest in using the symbol processor was clear throughout the course of the study. During the last week of school, all the students were invited to a stocking dance party which was scheduled at David's computer time. While he was dancing with his creative stockings, a teacher asked him if he wanted to continue dancing, or go work on the computer. When he heard the word, computer, he said, "Yes." When the teacher asked a second time, "Are you sure you want to go?" David responded again even more loudly and with a big nod.

Furthermore, David carried his interest in computers into his home. In a telephone interview, David's mother expressed that he often reminded her that he wanted a computer for his birthday. His mother also said that he never failed to show his computer printouts to family members.

Case 3. Bryon is an energetic 15-year-old boy classified as severely multiply handicapped. He has very good gross motor ability, but his fine motor skills are not as well developed. His communication skills, include some signing, some verbalizing and a great deal of pointing and gesturing. The most complex vocal expressions he makes are two-word phrases. His homeroom teacher reported that Byron had the ability to recall information and follow directions in the classroom:

When Bryon began using the symbol processor, he soon became one of the fastest writers. He seemed to especially enjoy increasing his speed on the system. Each time he came into the computer room with vigor and excitement, usually showing his emotions by laughing aloud, jumping up and down and clapping his hands. Bryon's accuracy was excellent in finding and understanding the symbols on both boards (See Figure 9). His speed progress was even more

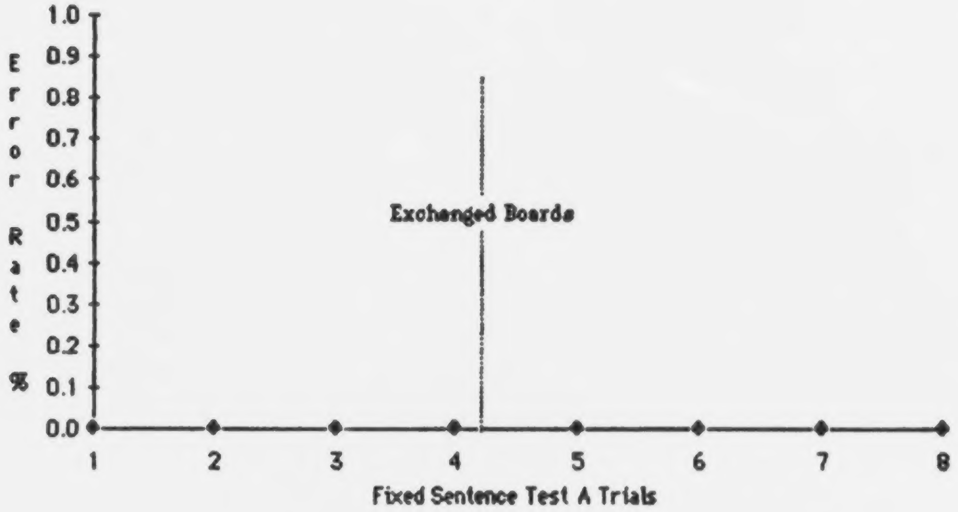


FIGURE 9 Byron's error rate using both boards.

impressive. He improved his speed on fixed sentences from 4 minutes 29 seconds to 46 seconds in only 4 trials (See Figure 10).

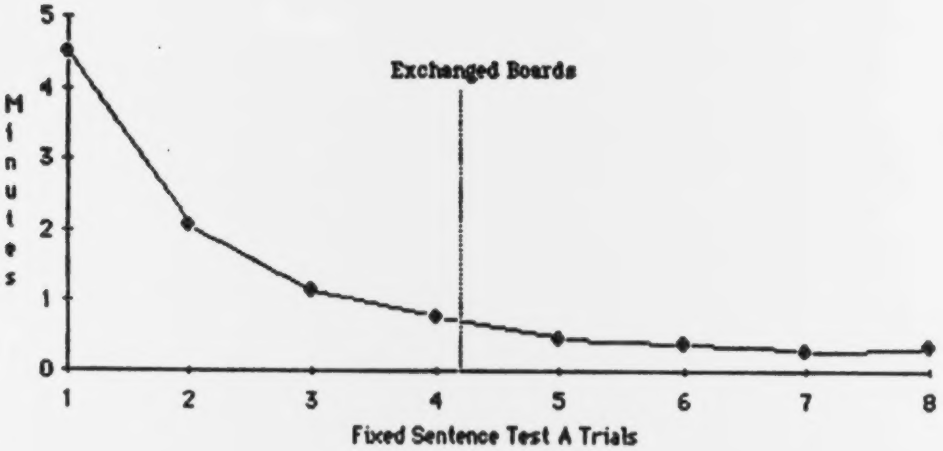


FIGURE 10 Byron's speed using both boards.

Numbers and colors were Bryon's favorite symbols. He often perseverated by going from one row to the next or pressing the same symbols again and again. However, Bryon was also capable of composing meaningful sentences even at the beginning of his free expression trials. For example, in one of his first attempts at free expression, he wrote to his teacher, "I like you. You good teacher."

During the first fur weeks of the study, Bryon spent most of each session selecting random strings of symbols, but would also usually compose at least one meaningful sentence. Included among his meaningful entries: "I have four brothers," "I want radio," and "I want ice cream."

As Bryon gained more experience with the system, he continued to improve in both the speed and the meaningfulness of his entries. During one session he wrote a 22-word letter in only 2 minutes and 20 seconds.

Bryon often wrote about his girl friend, watching television at home, and eating cookies. During one of his typical sessions, Bryon became so excited at his ability to create communication on the computer, he screamed and clapped his hands. He wrote, "I like computer. Computer helps me write letter..... I [am] happy to work on [the] computer."

In spite of his ability to create meaningful sentences, Bryon seemed to enjoy his random selections and perseveration of symbols far more than writing down organized thoughts, unless he had a great need to write, such as writing letters to his teacher and girl friends (See Figure 11).

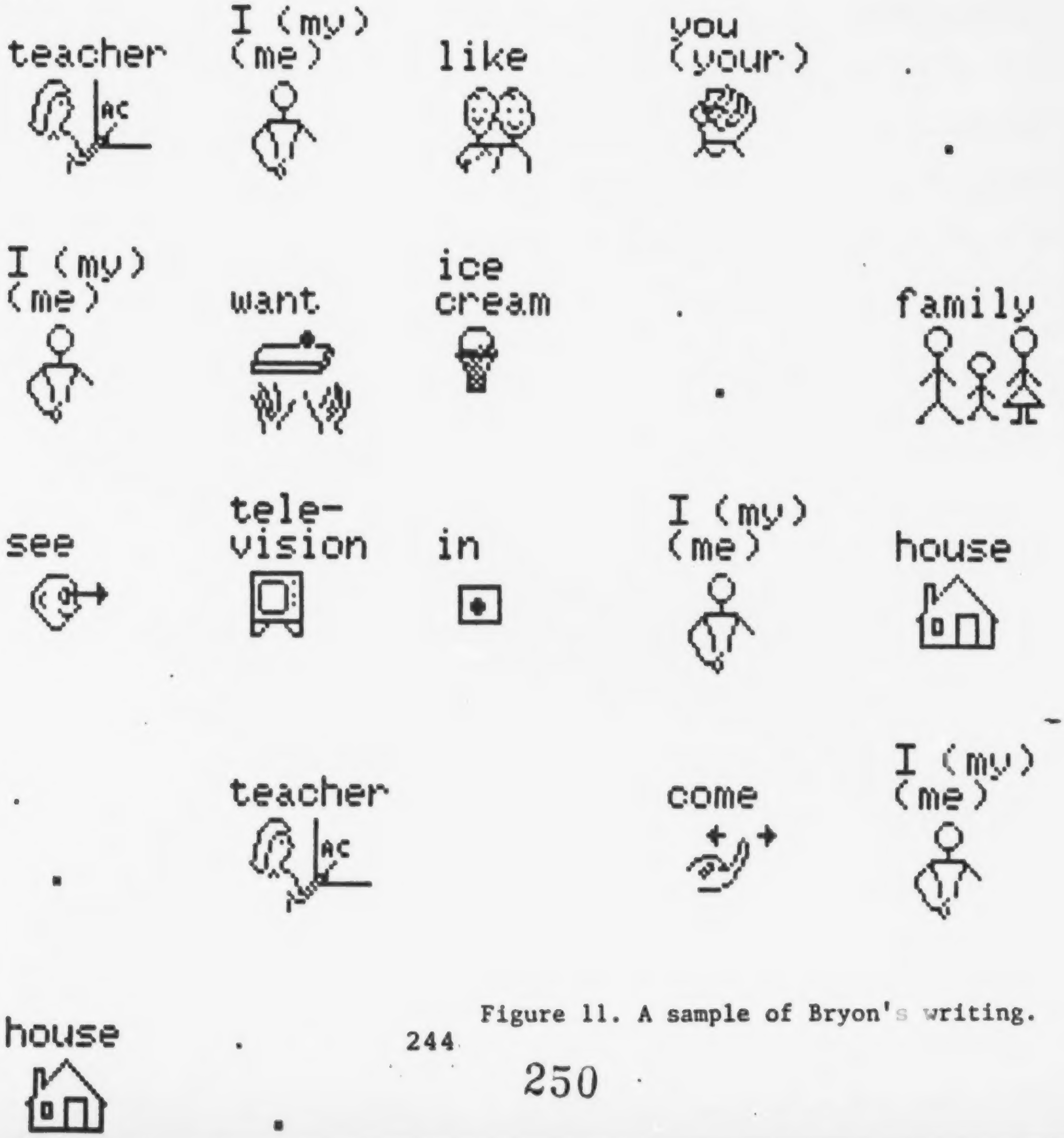


Figure 11. A sample of Bryon's writing.

This characteristic was in clear contrast to other students, like David who preferred to spend most of his free expression time creating meaningful communication.

One of the reasons for Bryon's success on the symbol processor was the support given by his teacher. Although most teachers were openly supportive of the project, Bryon's teacher seemed to take special interest in the progress her student was making on the system. On the last day of school his teacher came to the computer room and asked if she could write a letter to Bryon using the system to express her feelings as well as to remind Bryon of some summer events. After writing her letter to Bryon, she expressed her gratitude in being able to use the system, and then made a strong request that the project continue during the coming school year. Before she left, she described how Bryon's enthusiasm for symbol processing had become obvious to everyone in her class because Bryon always liked to show his letters to the class immediately after returning from the computer room. She also mentioned how Bryon would always remind her of his computer time and thought himself very special to take part in the project. It was this feeling of increased self-esteem that Bryon's teacher felt was the most important result of the symbol processing project.

Conclusions and Discussion

The results of the research reported in this article shows that students with severe communication impairments can be trained in a relatively short period of time to express themselves independently in writing. For students like Bryon and Edward, who have never before had the ability to express their thoughts in writing, symbol processing systems offers an important new dimension to their communication skills. For the majority of students participating in the research, it was the first time that they had ever seen their own words in print. Observers clearly noticed that students were as excited to read and reread their own printouts, as they were to create the communications. This finding has important implications for communication training. For example, there has been increasing evidence of the importance of personalizing early reading experience so that when a child is asked to read a passage, each of words is meaningful to the child (Smith, 1983). This theory has already caused many teachers to introduce writing much earlier in a child's education, so that children can read their own, as well as other children's communications. Although the theory has been developed primarily through observing nonhandicapped children, the data collected in the symbol processing studies indicate that print fluency (including symbol fluency) may be enhanced by allowing students to read their own communications. Further research is needed, however, before firm conclusions can be drawn regarding the role of symbol processing in improving print fluency.

Regarding the relative merits of the two symbol boards employed in the research, it can be concluded that both can be effectively used by severely and multiply handicapped students, although the Power Pad has some unique advantages over the Graphics Tablet. One important finding from the second study was that students generally did much better when they exchanged boards, regardless of which board they used first. The pen on the Graphics Tablet was not a serious deterrent to student performance, once students were accustomed to using an electronic board. However, the Graphics Tablet was not as dependable as the Power Pad, largely due to the sensitive connection between the pen and the computer. Students' sporadic hand movements sometimes broke the pen wires, requiring repairs. The Power Pad seemed to be more reliable, requires no interface card, and costs much less than the Graphics Tablet. These advantages, alone make the Power Pad a more attractive choice for symbol processing. However, it should be noted that other electronic boards currently exist (Greystone, P., 1984; Unicorn Engineering Company, 1984) and others will likely be developed, none of which were tested in these research studies. The desirability of alternate software and hardware configurations should be considered in continuing research on symbol processing.

In addition to testing other symbol processing systems, it is critical in future studies to broaden the population of users. In these initial studies students all possessed moderate to severe mental retardation in addition to a variety of motor impairments. However, since Rebus symbols are becoming more common as a tool for early reading instruction, symbol processing for learning disabled, and even nonhandicapped students should be researched. Anyone who is unable to write fluently using the traditional alphabet is a potential candidate for symbol processing. While the implementation of such programs and the intended benefits may vary, such research may provide valuable insights into early language development, as well as offer testable techniques for improving early reading instruction.

References

Carrier, J.K., Jr. (1974) Application of functional analysis and a nonspeech response mode to teaching language. In L.V. McReynolds (Ed.), Developing Systematic Procedures for Training Children's Language. ASHA Monographs, 18.

Clark, Charlotte R. (1981). Learning words using traditional orthography and the symbols of rebus, bliss, and carrier. Journal of Speech and Hearing Disorders, Vol. 46, No. 2, 191-196.

Clark, Charlotte R. (1984). A close look at the standard rebus system and blissymbolics. TASH Journal, Vol. 9, 37-48.

Greystone, P. (1984). Expanded Keyboards for Trace Center's Blissapple.. EKEG Electronics Co., Vancouver, B.C.

Osguthorpe, R.T., Li, L. & Applegate, L. (1985). Symbol processing for handicapped students. Internal publication, Brigham Young University, Provo, Utah.

Sailor, W. & Guess, D. (1983). Severely Handicapped students: An instructional design. Boston: Houghton Mifflin.

Smith, F. (1983). Essays Into Literacy New Hampshire: Heinemann Educational Books.

Unicorn Engineering Company. (1984). Unicorn expanded keyboards and the adaptive firmware card, Oakland, California.

# # #

Making Apple Computers Accessible To Blind Children

Andrew Renouf and Susan Phillips
Sensory Aids Foundation
Palo Alto, CA

Introduction

Today's children are learning through Computer Assisted Instruction (CAI) and gaining computer literacy as early as the pre-school age. There are an estimated 200,000 computers in educational settings throughout the United States with 600,000 expected by 1985 (Market Data Retrieval, 1983). While many children are preparing for success in our computer world, visually impaired children have been denied the experience of CAI as well as other opportunities to gain computer literacy. If continued, this lack of experience will widen the gap between these students and their sighted counterparts, needlessly compounding the disability.

In 1983, a review of the literature showed the Apple computer had been made to "talk" for a limited amount of software. However, this work was limited to use by visually impaired professionals and college students rather than visually impaired school children. Even the voice4 synthesizer peripherals presently available for Apple computers are of limited use because the lack of compatible software. It was because of these concerns that Sensory Aids Foundation (SAF) undertook the present project. We set out to test the feasibility of adapting off-the-shelf educational software to a speech synthesizer unit that was compatible with the Apple II personal computer and would be within the financial reach of most school districts. The project was to make any necessary adaptations to selected software and then test the efficacy of the speech synthesizer and adapted software in teaching children specific skills. The project was to also investigate the motivational effects of CAI on the participating children, as well as, the effects on their feelings about computers and computer use in general.

Methods

Subjects

Subjects for the project were 15 visually impaired students recruited from the San Francisco Bay Area. The students had varying degrees of visual impairment but no other disabilities. There were 8 female and 7 male subjects with an age range of 8-12 years old.

Materials

Subjects were administered a battery of pre- and post-tests. These included the Wepman Auditory Discrimination Test with the synthesizer speaking the words, a shortened version of the Minnesota Computer Literacy Questionnaire (Anderson, Johnson, Hansen, and Klassen, 1979), a standard typing test (4th grade level), and the Stanford Achievement Tests (Primary Levels II and III, Form A (4-2440 and 6-2234) by Richard Madden, Eric H. Gardner, Herbert C. Rudman, Byron Karlsen and Jack C. Merwin) for spelling and language (given at the appropriate grade-level for each child).

The Apple II computer was selected for the study because of the large number of existing units in the local school systems. Market Data Retrieval, 1983, reported an estimated 200,000 computers in educational settings throughout the United States with 600,000 expected by 1985. The speech synthesizer used was the Echo II by Street Electronics. After reviewing the available speech synthesizers, the Echo II was chosen for its compatibility with the Apple II, ease of use, and relatively low cost.

Three different educational software packages were tested. These included Echotype, a typing program developed by Sensory Aids Foundation from Mastertype by Scarborough Systems, The Spelling Program and The Language Program, the latter two developed solely by SAF.

Procedures

Subjects were administered the pretests for auditory discrimination, computer literacy, keyboard proficiency, spelling and language. Subjects then received tutoring with an Apple II computer for 30-45 minutes each week for as many as 15 weeks. All 15 subjects received instruction with the Echotype program, 10 subjects received instruction with The Spelling Program, and 5 received instruction with The Language Program. At the end of the instruction period, post-tests were administered.

Assessment

Because of the small number of subjects and the exploratory nature of the present study, statistical analysis of data would not have been fruitful. Thus, each case was looked at individually with the goal of identifying possible trends and suggesting further research questions.

Results and Discussion

Because of the method of assessment and the nature of the results, the Results and Discussion sections are combined so as to present the material more clearly. Thus, the project will be broken down by component and each will be assessed and discussed.

Efficacy of Speech Synthesizer

One of the concerns of the project was that the selected speech synthesizer, although possessing other desirable attributes, would not produce sufficiently clear speech to be useful to students. This would be especially problematic with software such as the Echotype program which requires students to accurately identify single words, as opposed to words in a sentence which can then be understood by using sentence structure and context as guides. These concerns were borne out by the results of the Wepman pretest. When identifying two words as the same, subjects were correct an average of 93% of the time. However, when the two words were different, subjects responded correctly an average of only 44% of the time. These scores were clearly due to the synthesizer's lack of fidelity which made distinguishing similar sounding words extremely difficult. We hypothesized that with repeated exposure to the mechanical sounding speech produced by the synthesizer. This, in fact, proved to be the case. In the Wepman post-test, subjects averaged 97% correct responses to the same-word pairs, and 56% correct responses to the different word pairs. These results were obtained with a maximum exposure to the speech synthesizer of 45 minutes per week. This limited exposure constrained the extent to which subjects could become adjusted to the synthesized speech. The experience of the two researchers who conducted the CAI, and thus, had more exposure to the synthesized speech, was that with increased exposure one becomes sufficiently accustomed to the speech. This is supported by the Wepman post-test results, although the extent to which subjects would adjust still needs to be more exactly determined. The difficulty of unclear speech can also be compensated for by adjustments in the actual software, which would change the incorrect pronunciation of words not consistent with the phonetic rules used in programming the synthesizer.

Software

An original goal of the study was to take off-the-shelf educational software and use it, with little or no adaptation, with the Echo II. However, early in the study it became apparent that, almost without exception, educational software is very graphics oriented, much of it to the extent that a "video game" format is followed. This dependence on graphics to convey educational content, while perhaps motivating for sighed children, makes the software unsuitable for adaptation to a voice synthesizer. The only software for which this was not the case was older public domain educational software. This was judged inadequate in terms of instructional content. Consequently, releases from the copyright holders of one piece of software (Mastertype by Scarborough Systems) were obtained so changes could be made. The remaining two programs were developed by SAF.

Most software on the market today is protected so that a programmer may not enter the program in order to "look" at how it was written without knowing the entry code for the particular piece. The negotiation time needed to obtain permission from the software publishers to make the necessary adaptations is often six months or more. It therefore, would be useful if writers of educational software could make available to special educators unprotected copies of their software.

Echotype

Not only are keyboard skills necessary to use a computer for someone with a visual impairment, they are usually an important aspect of that person's education as typing facilities his or her ability to complete schoolwork. Using Mastertype as a model, SAF developed the

Echotype typing program. As determined by the typing pre- and post-tests, all of the subjects showed considerable improvement in their typing skills. All the subjects learned the letters on the keyboard and all increased their typing speeds. One subject improved from not knowing any keys on the keyboard to typing 19 words per minute. Many subjects commented on how motivating it was to work on a computer. These improvements were seen with subjects receiving only one 30 minute session of CAI per week. Thus, the Echotype program appears to be an effective method for teaching typing skills to visually impaired students and additional sessions per week would increase this efficacy.

The Spelling Program

The Spelling Program was developed by SAF. The overall effectiveness of this program was difficult to assess due to its use by only 10 of the students and the small incremental difference in the spelling pre- and post-test scores. Anecdotal evidence indicates that this was a program that the students enjoyed and felt motivated to use. This program was the subjects favorite because they were able to enter their own word lists. As one subject put. "I like this one the best because I am programming it."

The Language Program

Due to a longer than anticipated development time, this program was tested with only 5 of the students. There was little increase from the language pre- to post-test scores, this being explained, at least partially, by the short amount of time subjects spent with this program. However, teachers found this program to be their favorite since they could enter any multiple choice questions for the students to practice.

Computer Attitude

One goal of the subject was to ascertain the effect of CAI on the computer-related attitudes of visually impaired students. This was done by using a shortened version of the Minnesota Computer Literacy Questionnaire. The questionnaire looked at five dimensions: Enjoyment, Anxiety, Efficacy, and Sex-typing. Each dimension was rated on a scale of 5-25. The results of the pre- and post-tests contained some expected and some unexpected figures (see Table 1).

	enjoy	anxiety	efficacy	sex
pre-	24.0	10.0	17.6	14.0
post-	22.6	7.9	17.9	19.3

Scores averaged across subjects.

Table 1

The first surprise was that enjoyment scores actually went down, although they still remained extremely high. This might be an indication that the original scores were inflated due to unrealistic expectations about computers. The second was that the sex-type score increased, which indicates a drop in sex-typing for computer use. This was surprising in that the synthesized speech product by the Echo II is rather masculine sounding. This was apparent to the researchers as well as to the subjects who remarked upon the fact a number of time. A closer look at the scores indicated that the change was due primarily to the female subject who showed a proportionately greater increase than the males in their post- versus pre-test scores.

The other scores show that with computer experience subjects' anxiety about computers decreased, while their feelings of efficacy in using a computer went up, albeit slightly. Apparently, the decrease in the enjoyment scores, perhaps due to unreasonable expectations, did not seem to have a detrimental effect on the degree of anxiety students felt about computers nor on their feelings of efficacy.

General Comments

The difficulties inherent to presenting statistical results to support a study such as this one are twofold. First, no matter what the results, they are statistically meaningless. Second, statistics inevitable fail to capture all of what occurred during such a project and thus provide only a partial description. What the numbers fail to convey are the reactions of the students and their Special Education teachers to the CAI. These reactions were consistently ones of enthusiasm, with students often being motivated to do work (such as typing lessons) on the computer that they would not do in the classroom. Among our students, motivation ran extremely high and this, according to their teachers, was directly attributable to the CAI. Students frequently cited reasons such as "Now I'm doing what the other kids do." or even "Now I'm doing things that the other kids aren't yet." as to why they found the CAI so motivating. It should be stressed that this was despite the prototypical nature of the software being used, which meant that it was not as sophisticated, and therefore as stimulating, as most of the present educational software for sighted children.

Conclusion

As a result of this project, 15 visually impaired students in the San Francisco Bay Area had the same opportunity as their sighted peers to use a computer. Our society is moving with increasing speed into the computer age and with the aid of projects like the present one, those of us with a visual impairment will be able to share in the new technology. Early exposure to computers is an important factor in motivating children to do further work with computers and to consider computer related careers. For the visually impaired or blind child this also means another opportunity to participate in mainstream society.

As one student in the 4th grade said, "I feel more a part of the kids in my regular classroom because I can do the same stuff they can with a computer using the voice synthesizer."

# # #

Computer-Assisted Fitting Of An Implanted Cochlear Prosthesis

J. Stephen Sinclair and Rosalyn Firemark
California State University, Northridge
Northridge, CA

and

Jerome I. Dickman
Humana Hospital-West Hills
Canoga Park, CA

Introduction

This paper covers recent work in the implantation of a multichannel cochlear prosthesis. During the past several years, cochlear implant technology has advanced so that practical devices may be offered to provide a beneficial sense of hearing to certain totally deafened adults.

Electrical Stimulation of the Auditory Nerve

For the past three decades, there has been steadily increasing research and clinical interest in an electrical device for stimulating the auditory nerve in persons with complete cochlear deafness. As seen in Figure 1, such a device would convert acoustic signals into an electrical stimulus, bypassing the outer and middle ear entirely and actively stimulating the terminal ends of the auditory nerve fibers located in the defective cochlea. If enough nerve fibers can be stimulated, the brain would receive sufficient nerve impulses for a sensation of hearing.

The earliest efforts of direct electrical stimulation of the auditory nerve in humans began in France in the late 1950's, with the first cochlear implants in the United States performed a few years later (Simmons, 1966). The House-Urban single-channel cochlear implant was clinically introduced in 1972 and with refinements has become the basis for an extensive implant program at the House Ear Institute (Edgerton et. al., 1983).

At the present time, there are at least five cochlear implant systems available or under development in the United States (ASHA, 1985), as shown in others and already has received "pre-market" federal Food and Drug Administration approval. The other systems are classified as experimental, requiring FDA approval for each implantation.

Three of the present systems differ from the 3M/House device in that they employ multiple stimulating electrodes. The signal processing strategies of each of the multi-channel systems are unique. What all of the single and multiple electrode systems have in common is the capacity to transform acoustic signals into electrical energy and to apply it to the auditory nerve.

At Humana Hospital-West Hills and CSUN, our implant team presently is conducting clinical trials with the 22-electrode device manufactured by Nucleus Limited, of Melbourne,Australia. We are part of a worldwide investigational program with the 22-electrode system involving approximately 28 teams of otologists and audiologists in the United States, Canada, Mexico, Australia, and West Germany. During the past two and a half years, more than 80 adults have been implanted with the Nucleus device, about half of these in the United States. Recently, our first patient received the Nucleus implant and is now undergoing the post-surgical rehabilitational program.

Rehabilitation Need

It has been suggested that hearing functions at three psychological levels: social-symbolic, warning, and primitive (Ramsdell, 1977). Total acquired deafness reduces perception of spoken language and diminishes recognition of non-linguistic acoustic events. It also may uncouple the individual from a constant, subconscious awareness of the surrounding world. Total loss of hearing may result, therefore, not only in a handicap for spoken communication, but also in feelings of isolation as the person is detached from all types of auditory stimulation.

Our multi-channel cochlear implant program seeks to remedy these problems by achieving five goals:

1. Provide awareness of sound;
2. Provide recognition of environmental sounds;
3. Improve speechreading;
4. Provide recognition of some auditory speech without visual cues; and,
5. Improve intelligibility of speech production when affected by deafness.

It is known that some of these goals can be attained, at least partly, by conventional auditory amplification, tactile stimulation, and speechreading (Ling, 1976). For example, as shown in Table 2, a single-channel vibro-tactile device can convey to totally deaf person such low frequency suprasegmental aspects of speech as duration, intensity and voicing. This information may be helpful to the deaf listener for resolution of the visual dilemma of phonemes which sound differently, but look alike in production (e.g., /p/ and /b/). Other segmental aspects of speech, such as place of articulation of some consonants, may be recognized by lipreading. From a glance at Table 2, however, it should be apparent that speech information perceived through visual and vibro-tactile channels is relatively impoverished when compared to auditory perception.

The single-channel cochlear implant generally is regarded as capable of providing at least the suprasegmental speech features also provided by vibro-tactile stimulation. The auditory percepts usually associated with the single-channel device have been likened to a buzz or a clang which tends to vary in loudness with different stimuli, but not vary in pitch. Thus, it is not possible to achieve open-set recognition of complex signals such as speech phonemes (Loeb, 1985; Bilger, 1983). Nonetheless, the single-channel implant may meet many rehabilitation goals, including sound awareness, recognition of environmental sounds, and enhancement of lipreading. Further, improvement in self-monitoring of speech production is often clinically observed.

The multi-channel cochlear implant offers the possibility of open-set speech recognition as well as further achievement of the other rehabilitation goals. This is due to the potential for pitch perception with a multi-channel device, using electrodes placed in various locations in the cochlea to electrically stimulate discrete bundles of auditory nerve fibers. Pitch perception allows for segmental speech information to be received by the brain and some recognition of vowels and consonants to occur. Several multi-channel approaches have been developed, including the "speech feature extraction" strategy employed by the Nucleus implant (Clark and associates, 1984; Millar, Tong, and Clark, 1984).

Equipment

Cochlear implants consists of two major generic components. The first is the implanted electronics package and its associated electrode or multi-electrode array. The electronics package is surgically placed within the area of the mastoid portion of the temporal bone. The electrodes are located near or in the cochlea, depending upon the type of device used.

The second major component is the externally located speech processor, with its input microphone and transmitter units. The function of the speech processor is to convert acoustic signals received at the microphone into electronic instructions, transmitted either percutaneously or transcutaneously to the internal electronics package.

Nucleus Electronics Package

As described by its manufacturer (Mecklenburg and associates, 1983) and shown in Figure 2, the implanted electronics of the Nucleus system consists of a Receiver-Stimulator (R-S), a Connector, and a 22 Electrode Array. The R-S is a hermetically sealed package about the size of an American quarter coin. It contains custom integrated circuits and certain passive components used to generate the stimulus pulse on a selected electrode. There is also an internal coil designed to receive a radio frequency signal from the external headset transmitter that supplies both the electrical power and stimulus parameters encoded by the speech processor.

The Connector allows each of the 22 active electrodes to be connected to the electronics in the R-S. The R-S may be disconnected and removed from the mastoid without disturbing the Electrode Array in the cochlea. Thus, it is possible to replace a defective R-S or provide an electronics package with refined technology at a future date.

The Electrode Array consists of a smoothly tapered, flexible silastic carrier supporting 22 platinum electrode bands. The bands range in diameter from .4 to .6 mm and are evenly distributed along the distal 17 mm of the carrier. The proximal 8 mm of the carrier's total length of 25 mm supports non-electrode stiffening rings. Each of the electrodes is separately welded to its own platinum-iridium wire connecting it to the R-S through a 22-way connector.

Nucleus Speech Processor

The Nucleus Speech Processor has three components: the Wearable Speech Processor (WSP), an input microphone, and a transmitter coil, shown in Figure 2. The WSP itself is only slightly larger and heavier than a conventional body-worn hearing aid. It contains semi-custom and custom hybrid integrated circuits, powered by three AA size batteries.

The input microphone and the transmitter coil are located on the headset, with the coil positioned on the skin adjacent to the implant R-S coil. The headset is connected to the body-worn WSP by a wire which may be run beneath clothing.

Clinical Evaluation for Implantation

There are three general criteria for candidacy in the Nucleus implant program. First, at the time of evaluation the patient must be an adult, defined as past the 18th birthday. Second, the onset of deafness must have occurred after age 5 years. Lastly, deafness must be so severe that the patient does not significantly benefit from conventional auditory amplification using well-fitted, powerful binaural hearing aids.

Overall, the pre-operative evaluation may be divided into four areas: audiological, speech production, psychologic, and medical.

Audiological Evaluation

There are two pre-operative audiological questions to be addressed. First, is there any auditory benefit from conventional amplification? This issue is resolved with a hearing test, a hearing aid evaluation, a month-long trial with binaural aids, and an exhaustive analysis of auditory perception using the Minimal Auditory Capabilities (MAC) battery. The MAC battery assesses performance at 13 auditory skills such as differentiation of noise versus voice, male versus female talker, question versus statement intonation, and discrimination of spondee pairs, as well as ability at the greater auditory skill of open-set monosyllabic word recognition (Owens and co-worker, 1981). Patients with any aided open-set word recognition ability, even if poor, are ruled out for implantation since the multi-channel cochlear prosthesis cannot guarantee even this minimal level of auditory skill. Also, the other MAC battery sub-test scores should be at or near chance levels for the patient to be considered an acceptable implant candidate.

The second pre-operative audiological question concerns speechreading ability. Baseline speechreading skill is first measured by recognition of open-set sentences without contextual cues, using the CID Everyday Sentence Test. Also, speechreading in a more realistic context is measured by a procedure called Speech Tracking (DeFilippo and Scott, 1978). Here, the examiner reads aloud short segments from a standard text until the patient repeats each section verbatim. The examiner moves from section to section of text only when the patient has correctly responded. The test lasts 10 minutes, with performance expressed as the average number of words per minute repeated by the patient. Using both listening and lipreading simultaneously, four separate speech tracking sessions comprise the pre-operative evaluation of this skill.

The audiologist also conducts questionnaires concerning hearing handicap and severity of any tinnitus and takes an extensive case history. By the end of the audiological evaluation, the patient and the patient's family, have been counseled regarding realistic expectations of the implant, operation of the equipment, and requirements for post-surgery rehabilitation.

Medical Evaluation

The purpose of the medical evaluation is fourfold. First, the otologist conducts an initial interview and physical examination of the patient. Certain laboratory studies are conducted to determine suitability for surgery. These include radiologic studies of the temporal bone, blood analysis, and electronystagmography. The otologist establishes the etiology of the hearing loss whenever possible and the potential as an implant candidate.

Second, the otologist and audiologist conduct a promontory test. This is direct electrical stimulation of the auditory nerve via a transtympanically placed needle electrode on the promontory of the middle ear. If the patient senses a buzzing sound to electrical stimulation, an indication exists of sufficient surviving auditory nerve fibers for implant stimulation.

Third, the otologist must rule out factors which contraindicate implantation. These would include a cochlea unable to accept an adequate length of the electrode array.

Finally, the otologist ensures that the patient understands the risks of surgery and the requirements for participation in the rehabilitation program. Once again, realistic expectations of both patient and family are discussed and questions are answered.

Other Evaluations

The candidate's speech production and language ability are formally assessed by a speech pathologist on our implant team. Recordings are made of the patient's pre-operative voice, reading from a standard text.

A psychologist also serves as consultant to the implant team. Evaluations are made of both the patient's and family member's expectations, motivation, and ability to cope with disappointment and difficulties with the implant device. Estimates are made of the patient's flexibility, learning ability, and intellect.

Implantation

The patient is hospitalized for several days prior to surgery for preventative antibiotics and postoperatively remains in the hospital for approximately three days of recovery. An additional two to three weeks of healing at home is necessary prior to electrical stimulation, although the patient resumes most normal activities during this time.

The R-S electronics package is surgically implanted into the mastoid of the ear to be stimulated. The Electrode Array is inserted through the round window of the middle ear into the scala tympani of the cochlea, as shown in Figure 3. This type of surgical procedure has been described by Michelson and Schindler (1983). Ideally, all 22 electrodes are inserted, a total distance of 25 mm into the cochlea.

The cochlea is tonotopically organized, so that auditory nerve fibers at the apex of the cochlea, near the distal end of the Electrode Array, respond best to low frequency stimulation. The nerve fibers at the basal end, near the round window, respond to the higher frequency sounds. By selecting which electrode to fire, a discrete pitch sensation may be possible if the electrical current can be narrowly restricted to a small area in the vicinity of the active electrode.

Post-Surgical Rehabilitation

Once the implant is in place and healing is completed, the external WSP must be programmed and the patient's training in auditory perception begins. Programming the WSP individually "tunes" the electrodes to operate within specific frequency bounds and at comfortable listening levels in order to provide certain features of speech and other sounds.

Figure 4 illustrates the "speech feature extraction" strategy of the WSP. Acoustic signals arriving at the microphone are amplitude compressed and analyzed. The fundamental speech frequencies, typically 100 to 300 Hz, are estimated and used to fix the pulse rate of electrode firing. The second format of the speech signal also is estimated by the WSP. This frequency will determine which of the electrodes is selected as the active electrode. The higher the second formant frequency, the more basal the electrode selected. Finally, the amplitude of the acoustic signal determines the level of electrical current provided to the selected electrode. All of this information is passed through an analog-to-digital converter, coded, and sent to the headset transmitter coil. This coil transmits electrical power and the coded signal through the skin via a 240 MHz carrier signal to the implanted R-S electronics package.

Recall from Table 2 how much of speech would be present if the information of the low frequency suprasegmental domain and the second formant was available: duration, intensity, voicing, and place of articulation for vowels and consonants.

Diagnostic and Programming System

The individualized fitting of the WSP is accomplished by the Diagnostics and Programming System (DPS). The system consists both of specially designed hardware and software. The hardware is shown schematically in Figure 5, with five basic components: A specially adapted Sanyo MBC-1000 microcomputer for interactive testing with the patient; a speech processor interface (SPI), developed by Nucleus for controlling the WSP with the computer during testing; a patient control knob for altering amplitude or pulse rate of individual electrodes; a simulator associated with the SPI for visual and auditory indication to the audiologist of operation of the WSP; and, finally, a Star Micronics DP8480 dot-matrix printer for making hard copies of data (Mecklenburg et. al., 1983).

Programming the Speech Processor (WSP)

There are three important measurements for programming the WSP. These are shown in Figure 6 in the software organization of the DPS. The first test is a determination of the usable dynamic range of each working electrode pair (an active electrode and an indifferent electrode in the array). This is the range between the threshold for 100 percent sound detection and the limit of maximal comfortable loudness of sound. Both of these values are recorded for each electrode pair.

The second psychophysical measurement is loudness balancing of all bipolar pairs of electrodes to determine if uniform loudness is experienced when electrodes are sequentially stimulated.

Lastly, electrode pairs are stimulated in serial order from distal-to-proximal position, or proximal-to-distal, which corresponds to electrical stimulation from either apex-to-basal, or basal-to-apex, in the cochlea. The purpose of this electrode sweep is to measure the patient's perception of changing pitch. The basal-to-apex sweep, for example, should result in a percept of "sharp" (high pitch) to "dull" (low pitch), corresponding to the tonotopical organization of the cochlea.

The results of psychophysical tests are recorded into the MAP section of the software and, when testing is completed, the data is transferred to the SPI to the patient's own WSP. This is done by transfer of the MAP information through the SPI to an EPROM (erasable, programmable, read-only-memory) chip in the WSP. The EPROM may be reprogrammed as many times as necessary during the rehabilitation program to provide the patient with optimal nerve stimulation from acoustic signals.

Rehabilitation Results

After initial programming of the WSP, the patient participates in a counseling program and intensive, structured practice in the use of processed signals.

Generally, the results of the Nucleus program have been encouraging for the role of multi-channel implants in rehabilitation of post-lingually deafened adults. Since the introduction the of Nucleus device in the United States is relatively recent, most of the clinical trial data is based on the longer term experience in Australia (ASHA, 1985; Mecklenburg and Brimacombe, 1985; Millar, Tong, and Clark, 1984; Clark et. al., 1984; Clark et. al., 1983). These results reveal no failure to achieve hearing sensation, no equipment failures, and average daily use of the device of at least 12 hours. Further, speech tracking rates have increased significantly. Remarkably, some patients reportedly were able to demonstrate a speech tracking ability on the basis of the cochlear implant alone. There are individual reports of limited telephone perception of speech by familiar talkers. In one analysis of 39 implantees, 36 showed improvement in lipreading, while in another analysis, 31 of 38 implantees had significant improvement in open-set speech recognition. (Mecklenburg and Brimacombe, 1985).

Our Humana Hospital-West Hills/CSUN team implanted our first patient in September, 1985. The implantee is a 24-year old CSUN student who was deafened at age 19 years from spinal meningitis. After approximately three weeks of post-surgical healing, the Nucleus implant was "turned on," and the rehabilitative program initiated. The early experiences of this implantee include:

1. At the initial psycho-physical tuning session, speech sounded high-pitched and unnatural, described by the patient as sounding like "little green men." No differentiation was possible between male and female voices. The patient was stimulatable by all 21 active

electrodes and was able to pitch-rank these electrodes in proper order. He had immediate 100% correct identification of a closed list of three spondees by hearing alone without practice. Also, without practice, he had 50% correct recognition of a closed list of 10 sentences by hearing alone.

2. At the second tuning session, the next day, the patient could distinguish male versus female voices and reported that speech sounded lower in pitch. He could detect the presence of running water in his kitchen. Other environmental sounds were expereinced as undifferentiated noise. The wearable speech processor was "fine tuned" at this session.

3. On the third day, additional "fine tuning" was required for the WSP's computer program. By now, the dynamic range between the threshold level of electrical stimulation and the level of discomfort was becoming quite uniform across all active electrodes. The patient described the sweep of electrodes as sounding like "running across piano keys, up and down a scale."

4. After one week, the patient was tested on recognition of an open-set list of local cities by hearing alone. he identified eight of ten cities. Accurate consonant perception was becoming apparent. The patient reported using the device in class and could tell when his sign language interpreter lagged behind or changed the professor's exact words, while looking only at the interpreter.

5. After a week and a half, the patient reported using his car radio. He could not understand words in music, but could tell that

music was being played.

6. After one month, the patient reported that use of the implant masks the tinnitus which developed from the meningitis. He is unaware of tinnitus even for several hours after turning the device off.

In Figure 7, the improvement in hearing provided by the cochlear implant can be seen. Unaided hearing thresholds pre-surgically were 110 to 120 dBHL at frequencies of 500 and 3000 Hz. With the most optimal fitting of a conventional hearing aid, thresholds improved onlyu to 55 to 60 dBHL at 500 and 1000 Hz. The response at 250 Hz with the hearing aid was only vibro-tactile. The hearing aid thresholds were still poorer than the level of ordinary speech at a typical conversational distance of four to six feet from a talker. Thus, the hearing aid could not provide any useful speech signal, requiring the patient to depend on sign language and speechreading skills for communication.

Hearing thresholds with the cochlear implant are 30 to 35 dBHL, well below the level of ordinary speech. This enables the patient to perceive the entire speech spectrum between 250 and 3000 Hz, comprising nearly all of the critical sounds for understanding speech.

Improvement in speech understanding is shown in Figure 8 after the first five weeks of post-surgical therapy. Pre-surgical speech tracking scores averaged 31 words per minute. With use of the cochlear implant, speech tracking scores have steadily imcreased to 55 words per minute, while lipreading alone scores are less than 20 words per minute.

As has been demonstrated, the multi-channel cochlear implant works and can be beneficial to deafened adults. The rehabilitation issue now is: How well can it be made to work?

Acknowledgements

Figures 1, 2 and 3 were supplied by Humana Hospital Corporation, Louisville, Kentucky. Figures 5 and Fiure 6 are from the Audiologist's Handbook for the Nucleus device (Mecklenburg, et. al., 1983).

The authors wish to express their appreciation to Humana Hospital-West Hills, Canoga Park, California, for support of the cochlear implant program.

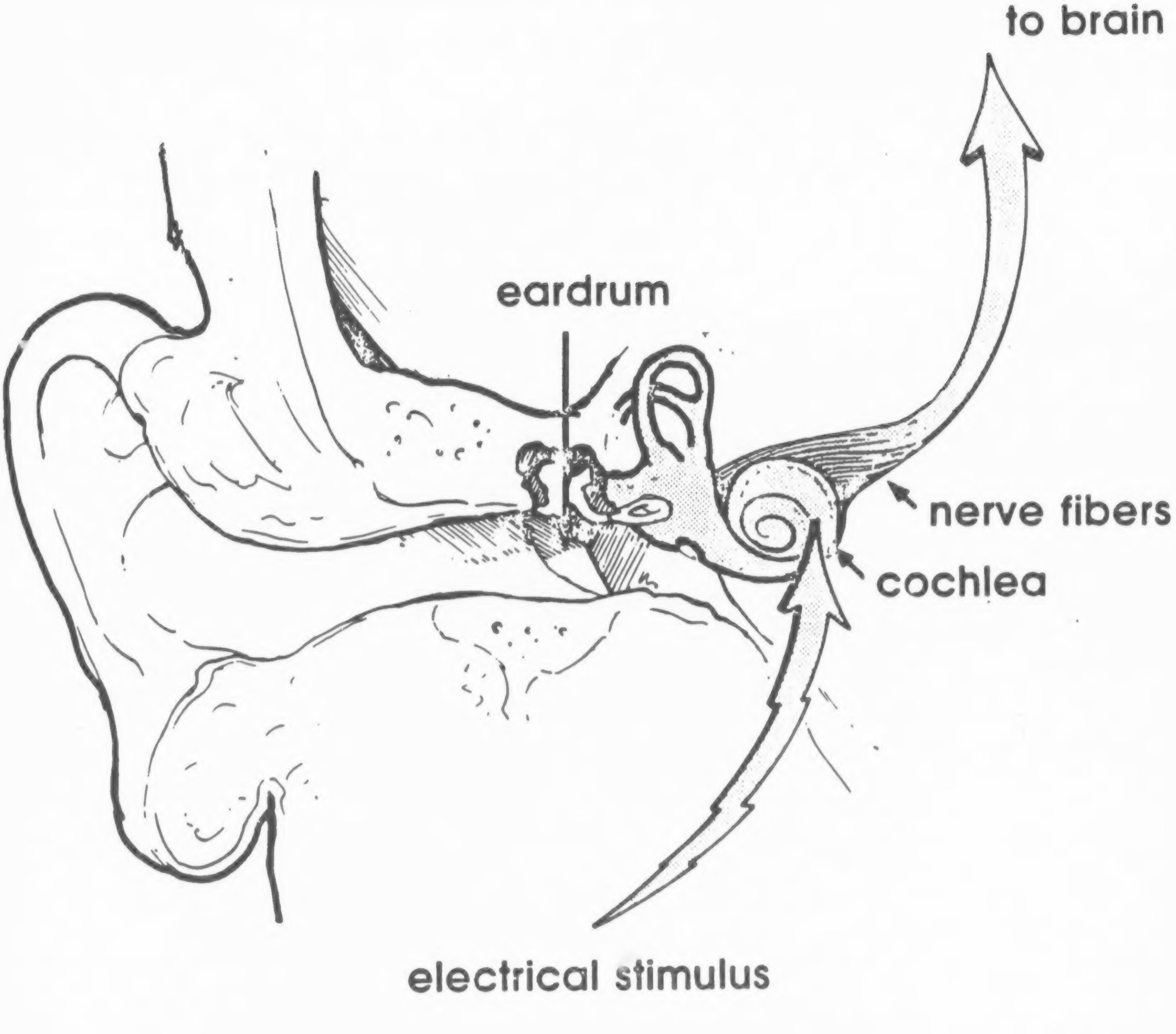
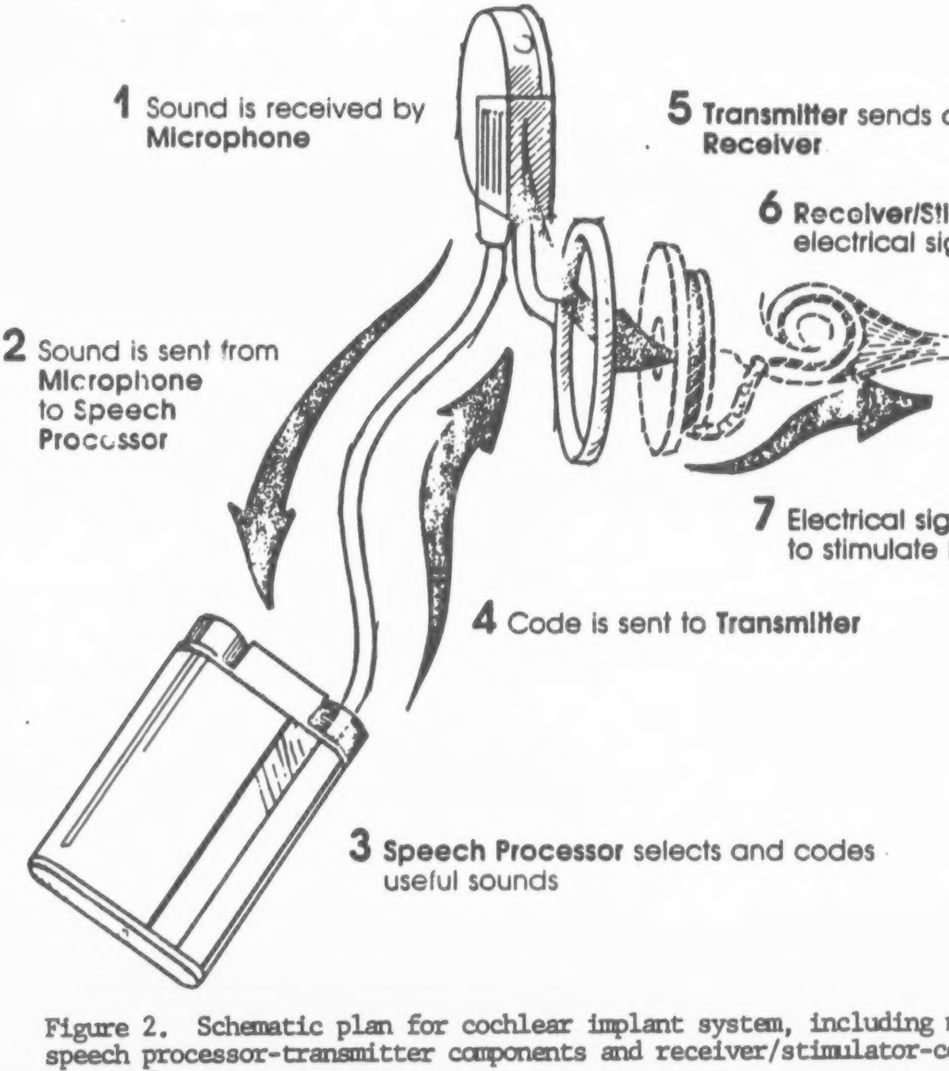


Figure 1. The cochlear implant provides electrical stimulation to the auditory nerve fibers terminating in the cochlea.

How The Device Produces Hearing Sensation Step-By-Step



1 Sound is received by **Microphone**

2 Sound is sent from **Microphone** to **Speech Processor**

3 **Speech Processor** selects and codes useful sounds

4 Code is sent to **Transmitter**

5 **Transmitter** sends code across skin to **Receiver**

6 **Receiver/Stimulator** converts code to electrical signals

7 Electrical signals are sent to **Electrodes** to stimulate hearing nerve fibers

8 Signals are recognized as sounds by the brain . . . hearing sensation

Figure 2. Schematic plan for cochlear implant system, including microphone-speech processor-transmitter components and receiver/stimulator-connector-electrode array components.

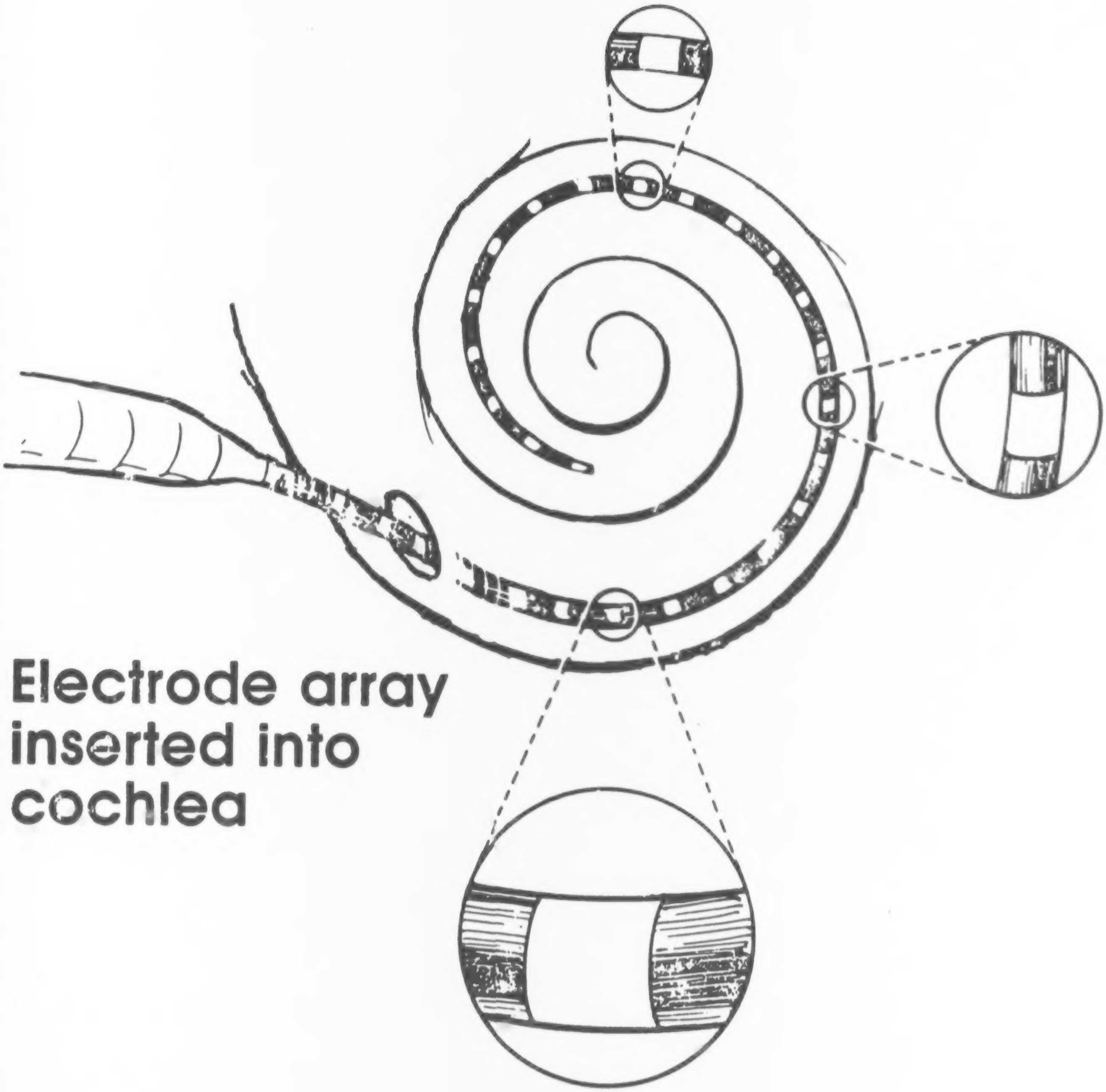


Figure 3. Schematic representation of electrode array insertion into the cochlea.

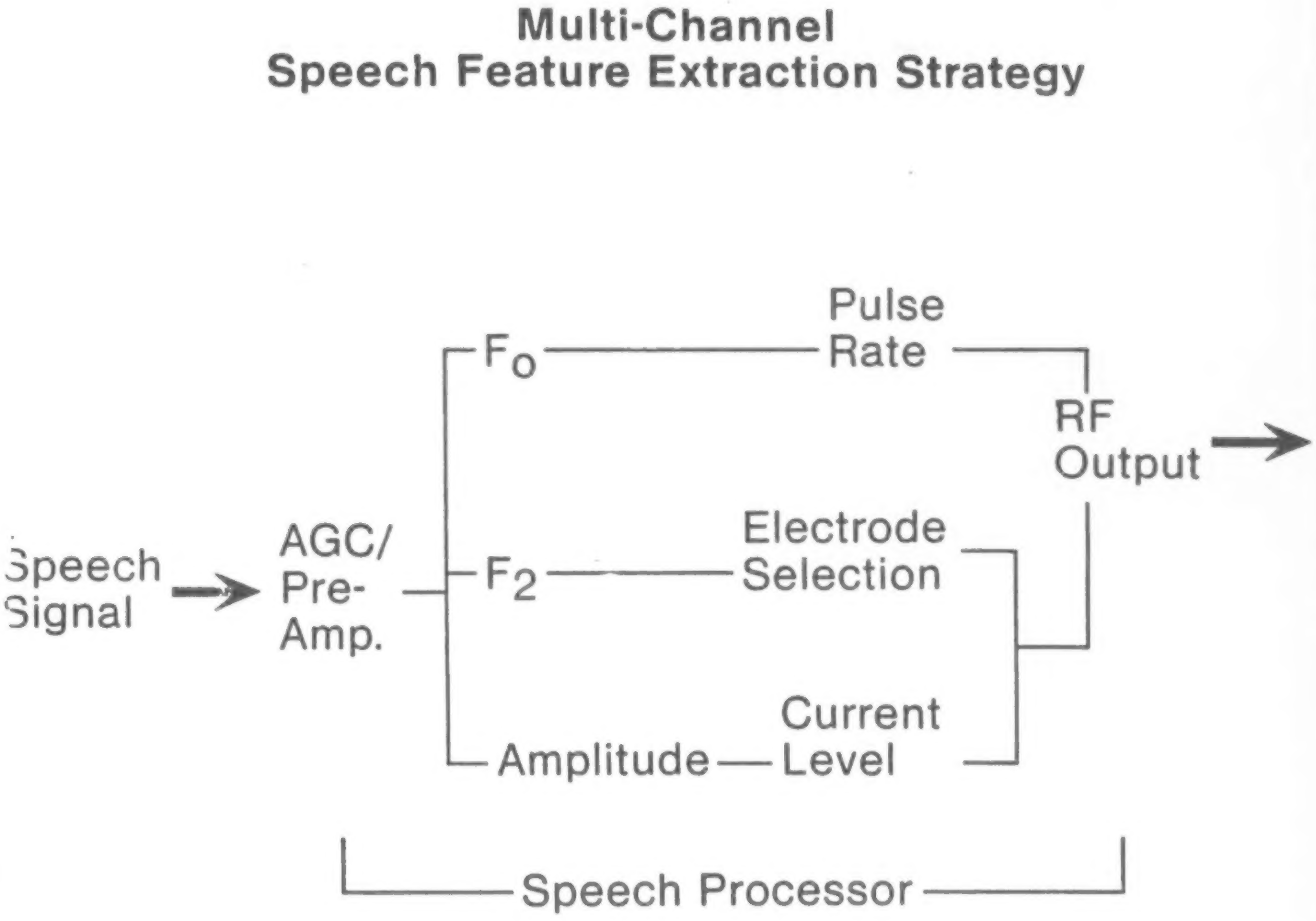


Figure 4. The Nucleus multi-channel speech feature extraction strategy in the WSP.

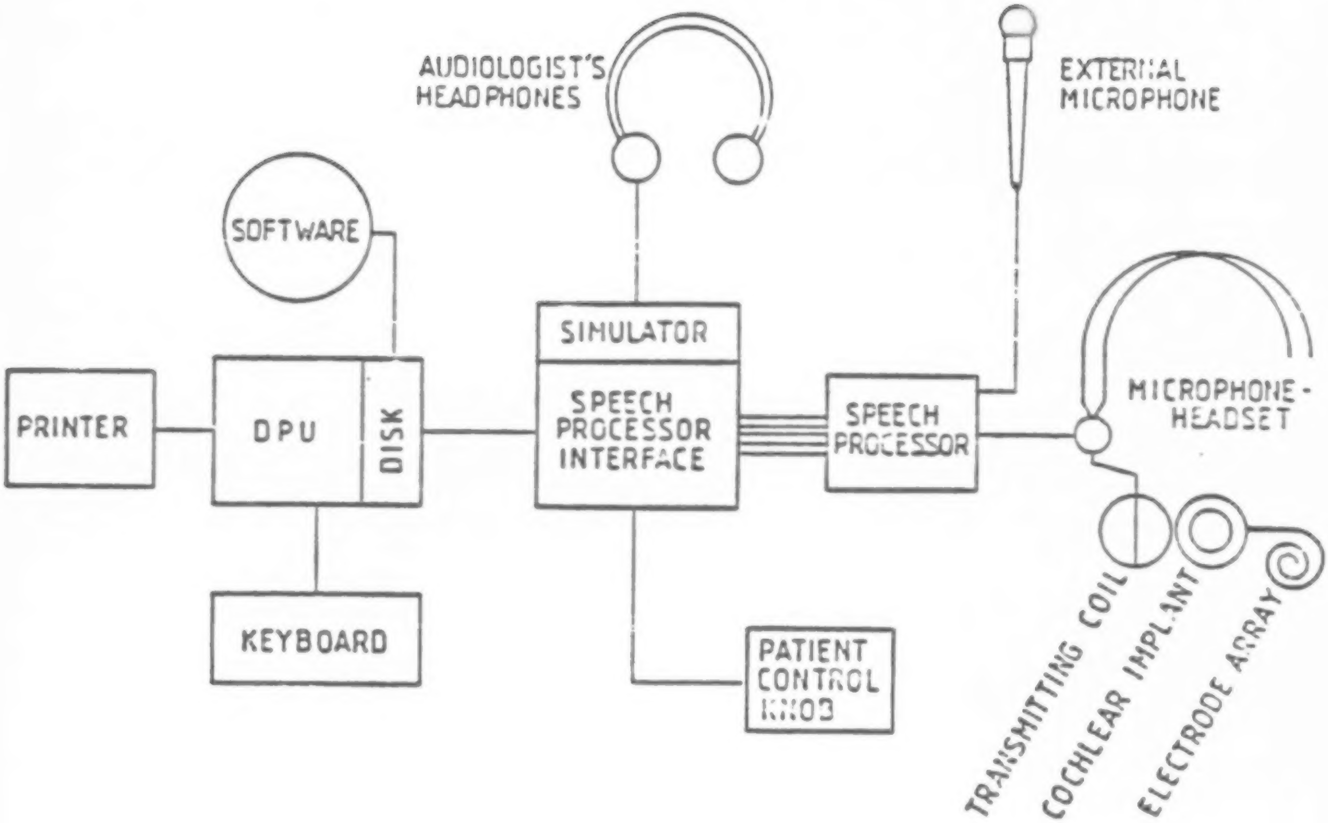


Figure 5. The Nucleus DPS hardware block diagram.

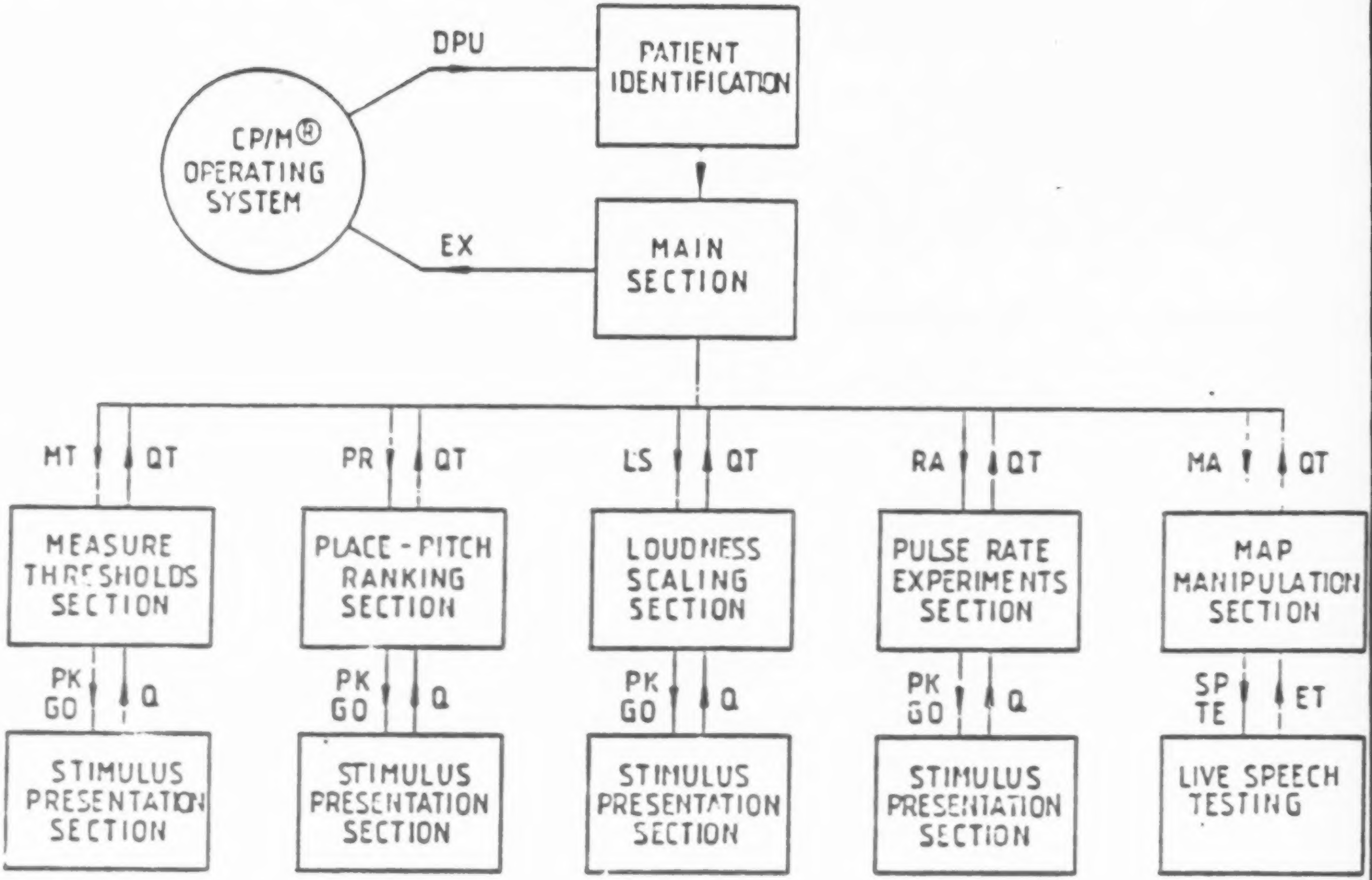

CP/M®
OPERATING SYSTEM
DPU
EX
PATIENT IDENTIFICATION
MAIN SECTION
MT
QT
PR
QT
LS
QT
RA
QT
MA
QT
MEASURE THRESHOLDS SECTION
PLACE - PITCH RANKING SECTION
LOUDNESS SCALING SECTION
PULSE RATE EXPERIMENTS SECTION
MAP MANIPULATION SECTION
PK GO
Q
PK GO
Q
PK GO
Q
PK GO
Q
SP TE
ET
STIMULUS PRESENTATION SECTION
STIMULUS PRESENTATION SECTION
STIMULUS PRESENTATION SECTION
STIMULUS PRESENTATION SECTION
LIVE SPEECH TESTING

Figure 6. The Nucleus DPS software organization.

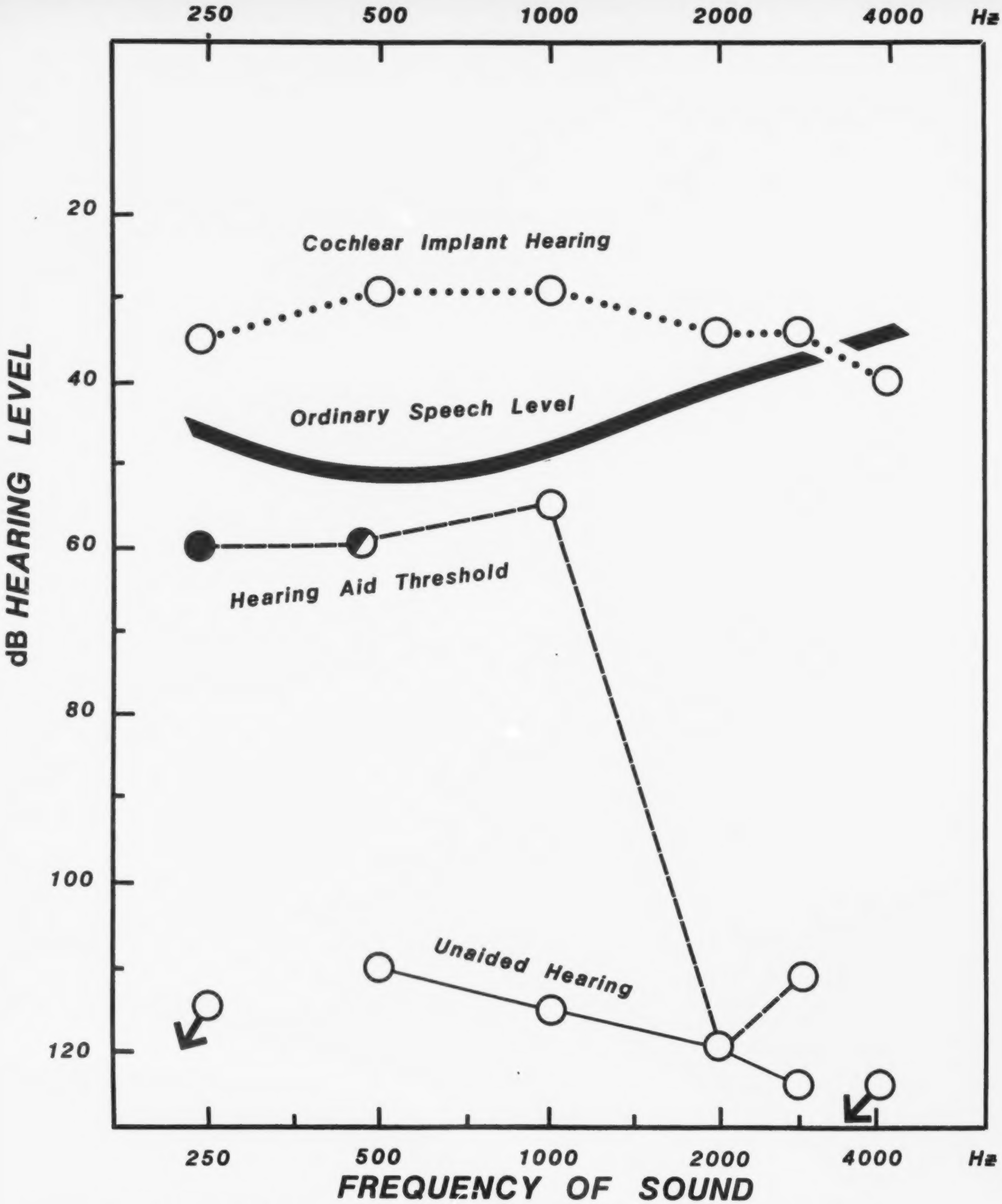


Figure 7. Patient audiogram showing pre-surgical unaided hearing, pre-surgical aided hearing using a conventional, powerful hearing aid, and hearing thresholds using the cochlear implant. The dark curve represents the level of conversational speech at a distance of four to six feet from the talker. The closed or partially closed circles represent hearing thresholds which were vibro-tactile or probably vibro-tactile. The arrows indicate no response to auditory stimulation.

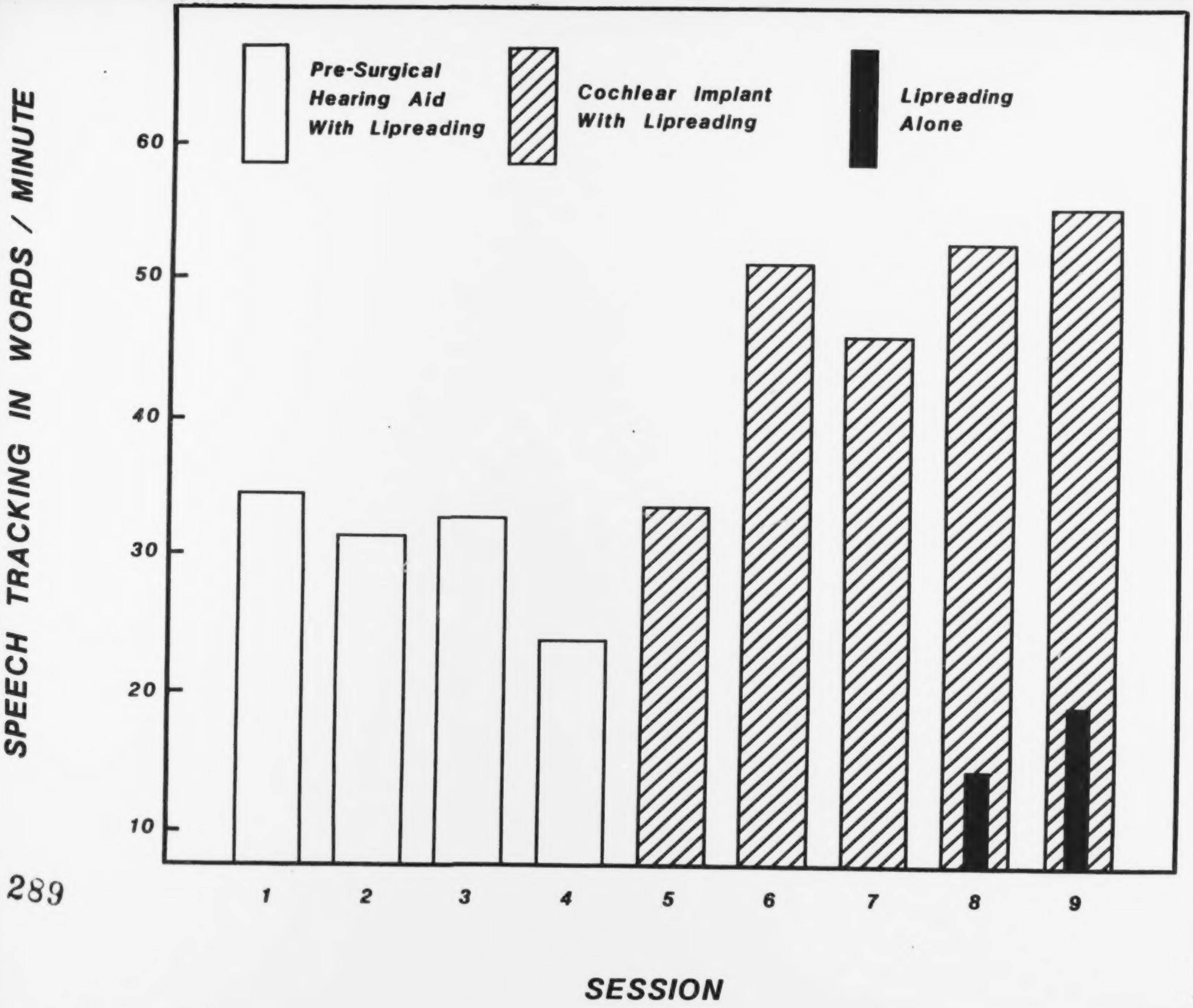


Figure 8. Speech tracking results on one patient who has received the 22-channel cochlear implant. Data was obtained in sessions one week apart, except for a four week break between sessions four and five for the implant surgery.

Table 1. Cochlear implant systems available or under development in the United States in May, 1985 (adapted from ASHA, 1985)

System	Electrodes	No. of Implants	FDA Status
3M/House	1	650	Approved - Adults
Nucleus/Cochlear Corp	22	80	Approved - Adults
Storz/Univ. Cal San Fran.	4	1	Experimental
Symbion/Univ. Utah	6	6	Experimental
Biostim/BIOEAR	1	10	Experimental

Table 2. Types of speech features available (+), partly available (P), or unavailable (-) in speech reception through normal audition, touch, and vision (adapted from Ling, 1976).

Sense Modality	Suprasegmental Features		Vowel Features*			Consonant Features		
	Duration	Intensity	F_o	F_1	F_2	Manner	Place	Voicing
Audition	+	+	+	+	+	+	+	+
Vibration	+	+	-	-	-	P	-	P
Vision	P	-	-	P	P	-	P	-

*F_o = vocal fundamental; F_1 = first formant; F_2 = second formant

References

Anon. Cochlear implant: five companies respond to ASHA survey. *ASHA, 27* (May), 27-34, 1985.

Bilger, R.C. Auditory results with single-channel implants. In C.W. Parkins and S.W. Anderson (eds.), *Cochlear Prosthesis: Ann. New York Acad. Sci., 405,* 337-342, 1983.

Clark, G.M., Dowell, R.C., Brown, A.M., et.al. Clinical trial of a multiple-channel cochlear prosthesis. *Med. J. Aust., 2*, 430-433, 1983.

Clark, G.M., Tong, Y.C., Patrick, J.F., et. al. A multi-channel hearing prosthesis for profound-to-total hearing loss. *J. Med. Eng. Tech., 8*, 3-8, 1984.

DeFilippo, C.L., and Scott, B.L. A method of training and evaluating the reception of ongoing speech. *J.Asouct. Soc. Amer., 63*, 1186-1192, 1978.

Edgerton, B.J., Doyle, K.J., Brimacombe, J.A., et. al. The effects of signal processing by the House-Urban single-channel stimulator on auditory perception abilities of patients with cochlear implants. In C.W. Parkins and S.W. Anderson (eds.) *Cochlear Prostheses: Ann. New York Acad. Sci., 405*, 311-322, 1983.

Ling, D. *Speech and the Hearing Impaired Child.* Washington, D.C.: A.G. Bell Assoc., Inc., 1976.

Loeb, G.E. Single and multi-channel cochlear prostheses: rationale, strategies, and potential. In R.A. Schindler and M.M. Merzenich (eds.), *Cochlear Implants*. New York: Raven Press, 1985.

Mecklenburg, D.J., and Brimacombe, J.A. An overview of the Nucleus cochlear implant program. *Sem. Hear., 6*, 41-51, 1985.

Mecklenburg, D.J., Dowell, R., Crosby, P., et. al. *Nucleus Implantable Hearing Prosthesis: Audiologists Handbook*. Melbourne, Australia: Nucleus, Limited, 1983.

Michelson, R.P., and Schindler, R.A. Surgical approach for insertion of multi-channel electrodes into the scala tympani. In C.W. Parkins and S.W. Anderson (eds.) *Cochlear Prosthesis: Ann. New York Acad. Sci., 405*, 343-347, 1983.

Millar, J.B., Tong, Y.C., and Clark, G.M. Speech processing for cochlear implant prostheses. *J. Speech Hear. Res., 27*, 280-296, 1984.

Owens, E., Kessler, D.K., Telleen, C.C., and Schubert, E.D. The minimal auditory capabilities (MAC) battery. *Hear. Aid. J.,* 34 (Sept.), 9, 32-34, 1981.

Ramsdell, D., in Davis, H., and Silverman, S.R. (eds.), Hearing and Deafness (4th ed.) New York: Holt, Rinehart, and Winston, 1978.

Simmons, F.B. Electrical stimulation of the auditory nerve in man. Arch. Otol., 84, 24-76, 1966.

# # #

Computer Technology For Communicatively Handicapped Pupils In Public Schools

Doris Soroky, Joe Abel, Kathy Boyle, Sally Cook, Nancy Kahn
and Peggy Morrison
Los Angeles Unified School District
Los Angeles, CA

The presenters have prepared a multimedia presentation which will provide the design and strategies necessary to implement computer based programs in a public school setting.

1. Cooperative Project to Develop Microcomputer Software to Stimulate Language Development for Physically Handicapped Preschoolers

The Los Angeles Unified School District and the University of California at Los Angeles Department of Pediatrics, Handicapped Children's Program formed an interdisciplinary microcomputer team for evaluating the speech and language behavior of handicapped preschoolers.

This team has developed for this population software which incorporates graphics, voice synthesis, and alternate input devices.

The language and speech specialists assigned to the University of California at Los Angeles preschool intervention programs were available to provide 1) information on available computerized software language programs, 2) information in the use of appropriate techniques and methodologies to teach language to nonverbal pupils in preschool and kindergarten programs, and 3) information to develop appropriate adaptations for pupils who were working with computers available in the special education schools.

2. Non-Verbal Assessment Program Center and Mobile Unit

The Division of Special Education, Los Angeles Unified School District, operates a Non-Verbal Assessment Center and a mobile unit to assess nonspeaking handicapped students age 3-21. It was the purpose of this program to assess the student, prescribe a type of expressive device for communication and educational purposes, and adapt and modify the available device to meet the needs of the student.

A group of manual and electronic devices for non-verbal individuals has been developed which, with appropriate modification, may offer the pupil an augmentative method for communication. Interface modes have been successfully adapted which allow communicatively handicapped individuals the opportunity to operate communication aids.

The Non-Verbal Assessment Programs provided 1) in-depth language and speech assessment, 2) language program planning, 3) speech and language instruction, 4) inservice for teachers and parents, 5) follow-up assessment and programming, and 6) adaptations, mounts, switches, etc., to enable pupils to operate the selected communication devices.

3. Computer Based Instruction to Improve Written Communication Skills of Senior High School Communication Handicapped Students

One Severe Disorders of Language/Aphasia and two Deaf and Hard of Hearing classes located at Gardena High School in the Los Angeles Unified School District were involved in a computer based instructional program to improve written communication skills. A consultant from the Department of Communicative Disorders, California State University, Long Beach and four student volunteers selected from the same department helped teachers to assess students, to write instructional objectives for written communication and to implement the instructional program on the high school site. Volunteers were used at the direction of the special day teachers to help students complete written language assignments using a word processing program on the computer. Students were taught to compose, revise, edit and print their own written compositions. Pre-post testing was done using the Test of Written Language and the TOLD-I combining sentence subtest to determine student improvement in written language. A survey evaluating computer instruction was also completed by all students, personnel and university volunteers. Results with be shared.

4. Computer Assisted Language Sample Analysis

A series of inservices was established to train Severe Disorders of Language/Aphasia teachers and itinerant Speech and Language Specialists to gather spontaneous oral language samples, analyze the samples using a microcomputer language sampling analysis procedure, develop goals and objectives based on the analysis and carry out a remedial program to improve the oral language skills of their students.

# # #

Visagraph Eye-Movement Recording System

Bonnie Talluto
Instructional/Communications Technology
Huntington Station, NY

During this presentation, I will:

- *describe a new eye-movement recording system known as the Visagraph.
- *clarify the significance of eye movements.
- *and point out how the Visagraph can be used as a survey and diagnostic device to improve reading at all levels.

First, let's explore the nature of eye movements and reading:

Reading is a complex process involving close interaction between some thirty-seven visual/functional, perceptual, and cognitive functions according to Taylor.[7] A reader's eyes coordinate as they move along the lines of print in a left-to-right fashion, pausing three to five times per second to perceive words or words-parts which are continuously processed into larger units of meaning. The reader interprets what is read in light of his/her experimental background, associates information, and projects beyond it in terms of association, judgments, applications, and conclusions.

Eye-Movements:
- •Reflections of reading efficiency
- •Judgments about reading effectiveness

The eye-movement activity or oculo-motor performance employed during reading reflects a student's acquired reading behavior which in turn represents that student's visual/functional, perceptual, and cognitive adaptations over a period of time.

Through the recording and analysis of a student's oculo-motor activity, a teacher of reading can make direct objective evaluations concerning a reader's efficiency and indirect judgments about his/her effectiveness.

You might think of eye-movement recording as a time and motion study of the reading process which can allow one to make judgments about certain aspects of a student's silent reading ability.

- Ease and comfort
- Energy
- Time (rate of reading)
- Comprehension potential
- Enjoyment

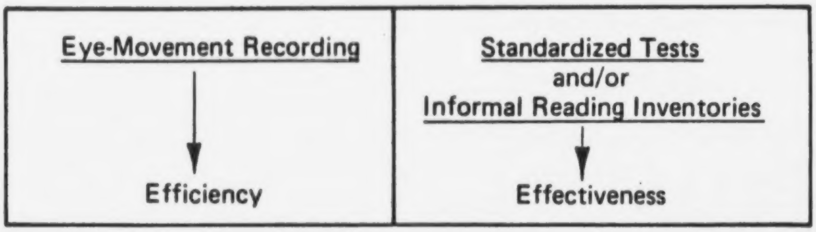
*Ease and Comfort - Does reading appear to be a visually coordinated and a comfortable activity?

*Energy - Is the student reading in an expeditious manner, with an appropriate amount of visual activity to complete the reading task?

*Time - Can the student read at reasonable rates, completing reading tasks in a reasonable period of time?

*Effectiveness - Can the reader read in a manner that is orderly in terms of perception and in a manner that facilitates retention and comprehension?

*Enjoyment - Has the reading process become one that will encourage habits of recreational reading?



Eye-movement recording can now furnish the teacher of reading with essential insights about a reader's efficiency. Information furnished by standardized diagnostic reading tests or informal inventories largely provide information about a student's effectiveness. When both sources of information are combined, you will have the most complete appraisal of a student's reading capabilities, needs, and level of attainment.

Let's explore how one acquires an oculo-motor activity.

When children come to school, they already possess habits of visual performance that are conditioned by their various looking experiences. These looking-learning experiences are largely distant-vision oriented, do not typically require find discrimination, and usually result in the tendency of the child to move his/her eyes very frequently, on the average, 3 times per second.

Then reading is encountered: a near point visual activity which is unnatural physically, demanding, from a vision and visual/functional standpoint, but necessary to learning.

- Vision
- Binocular Coordination Fusion
- Motility
- Directional Attack

Some children may be handicapped to varying degrees by imperfect vision, inadequate binocular coordination, or may experience problems with fusion (the ability to maintain single vision), motility (the ease with which visual movements are made), as well as experience difficulty acquiring a good directional attack (the ability to move the eye efficiently in a left-to-right manner along lines of print).

In this developmental process, it is important to understand the interdependency of the visual sensory process and the cognitive process. Inadequacy in either process will continually influence the development of the other.

- Basal word load
- Oral reading
- Overstress on phonics
- Comprehension difficulty
- Lack of confidence

Consider, also, the basal word load. In a typical first-year basal reading program, children are introduced to between 350 to 800 new words. The quantity of new words encountered each week in basal reading content will, unless sufficient word recognition mastery practice has been provided, continuously condition a non-fluent reading behavior. This behavior will be characterized by an excessive number of fixations and regressions as a student pauses and stalls to gain time to recognize new or unfamiliar words.

Round-robin oral reading can also, according to the results of a study by Gilbert,[3] encourage and condition an excessive number of random ocular movements as children follow along in their books while other children read aloud slowly and laboriously.

Then, too an overstress on phonics in the primary grades can cause some children to analyze words compulsively. This results in a tendency to over-analyze and vocalize all words read. This will limit the development of fluency in silent reading and can result in an excessive amount of oculo-motor activity in later grades.

Should the child also experience unusual *difficulty with comprehension* or *experience social condemnation* when attempting oral reading, or *lack the necessary confidence* in his/her ability to read, the result could be an unsatisfactory adjustment to the reading act which can take the form of tremors in eye movement, excessive head movement, blinking, random ocular movements, and an excessive amount of fixations and regressions.

So as most children struggle with word identification and recognition and to understand what they read, they are *not*, in most traditional basal reading programs, provided with the opportunity to develop any great degree of efficiency in the manner in which they read. *To the contrary, most beginning readers are subjected to a variety of factors which condition a perceptual and oculo-motor behavior that is conducive to the formation of inefficiency in silent reading.*

And over a period of time, this oculo-motor activity becomes rather habitual for most readers. While a reader's performance does mature and improve through the grades as his/her reading ability improves, the majority of students will not become very efficient in their manner of reading and, as a result, they will not become the flexible, sensitive readers we all desire.

Taylor, Frackenpohl, Pettee,[8] Litterer,[4] Morse,[5] Ballantine,[1] and Seibert[6] studied the effect of varying the difficulty of content and types of prose on reading performance. All of these studies bear out the existence of habits of oculo-motor performance and show that the average reader alter his/her eye-movement pattern performance *only slightly* unless the material is far beyond him/her in difficulty.

This is not to say that a reader's oculo-motor performance cannot be varied somewhat, but research does support the fact that the majority of readers will perform somewhat habitually unless the reading demands are extraordinary. In fact, the more inefficient the reader, the more rigid and habitual the oculo-motor performance during reading.

Can the *efficiency* of a reader be changed by training? Yes, changes in visual/functional, perceptual, and information processing skills can be improved by training just as changes in reading *effectiveness* can be improved through instruction in various comprehension skills and strategies.

- Eye-movements are relatively involuntary
- Eye-movements reflect habits of reading performance

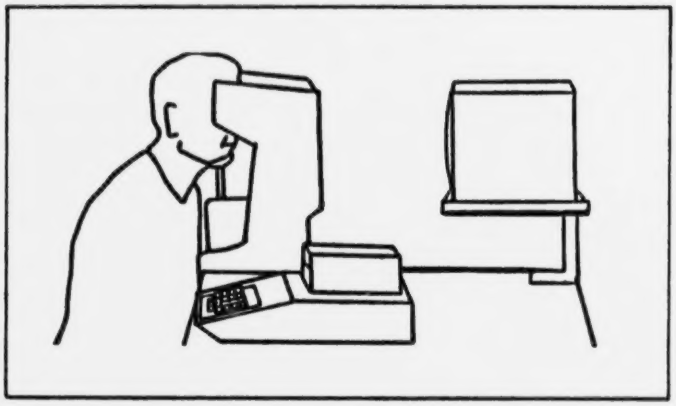
It is important to realize that the oculo-motor activity of the majority of students, being less efficient than desired, cannot be changed by voluntary control. Studies by Carmichael and Dearborn[2] aptly summarize this fact. "The normal reader cannot voluntarily control the number of his fixation pauses, regressive movements, or the other regular actions of his eyes as he reads. It is possible, through very specific training, to change the frequency and character of such movements, but this is not accomplished merely by ¶consciously trying' to do so."

Before we progress to how students may be trained to read more efficiently, let's look briefly at the process of eye-movement recording historically and learn about the opportunities afforded by the latest development in eye-movement recording, the Visagraph.

For background, let's look at a sound filmstrip entitled "Visual Activity of Reading."

- Projection of The Visual Activity of Reading -

Now the process of eye-movement recording has been simplified and expanded through the introduction of the Visagraph



The Visagraph combines the ease and accuracy of electronic sensing and recording with the flexibility, extensive memory, and analytical capability of the computer.

As student looks through the Visagraph viewer, he/she follows a moving X to align and calibrate his/her ocular performance. Then a reading selection is presented in several frames. During this reading, all eye movements are sampled at the rate of 50 times per second. Following this recording, the eye-movement data can be presented in graph form, in calculations of performance, or displayed against the content read.

Let's look first at how a recording is made with the Visagraph:

- Demonstration of the Visagraph -

Uses of Eye-Movement Recording

In schools, the principal use of eye-movement recording with the Visagraph will be to survey students' reading efficiency and to diagnose students' reading performance to determine the need for fluency training, and to consider the types of fluency training to be prescribed.

Eye-movement recording
as a survey technique:

•Grade 3 •Grade 6 •Grade 11

The most critical points where eye-movement recording should be used as a survey technique are as follows:

*Grade 3 - to ensure that students possess a reasonable level of reading efficiency as preparation for the more extensive and complex text-type reading and study activities they will encounter in the intermediate grades.

A reasonable goal at this point would be a reading rate in excess of 175 words per minute with commensurate efficiency in terms of oculo-motor characteristics.

*Grade 6 - to ensure that students' reading efficiency levels are sufficient to prepare them for the more extensive reading study and research tasks they will face at the secondary level. Furthermore, high levels of reading fluency are essential for truly effective skimming and scanning activities which students should engage in at the secondary level to be truly effective in their studies. A desirable goal at this point would be a reading rate in excess of 250 words per minute with accompanying efficiency in terms of oculo-motor characteristics

Grade 11 (college bound) - again to ensure that students who are college bound are prepared for the more extensive reading tasks they will encounter in their advanced studies.

A reading rate deemed suitable for the amount of assigned reading at the college level would seem to be 375-400 words per minute with accompanying appropriate oculo-motor efficiency.

Certainly eye-movement recording could be used at many other points in a student's reading career, but these seem to be the most critical checkpoints.

Eye-movement recording:
diagnosis

Eye-movement recording can also be an effective diagnostic tool to be used in conjunction with any reading improvement program. Eye-movement recording can:

*determine the need for fluency development.

Based on grade level norms, judgments can be made as to a student's need for fluency building techniques to improve his/her efficiency in reading. Eye-movement recording can:

*suggest the types of fluency training to be used.

To a degree, the types of fluency building techniques to be used can also be suggested by studying the oculo-motor deficiencies in eye-movement recordings. These charts briefly suggest some of the symptoms and possible training recommendations.

Symptoms:	Training Recommended:	
• Excessive number of fixations (eye stops) and accompanying reduced span of recognition (amount of words or word-parts perceived per eye stop)	Guided Reading training Tach-Mate training Vu-Mate training	PAVE Program Word Memory Program Processing Power Program
• Excessive number of regressions	Guided Reading training	Word Memory Program Processing Power Program
• Unusually prolonged duration of fixation (length of eye pause)	Tach-Mate training Vu-Mate training	PAVE Program Word Memory Program
• Poor directional attack • Inadequate return sweeps	Guided Reading (especially Visual Efficiency training)	PAVE Program Processing Power Program
• Habitual re-reading	Guided Reading training Read/Along training READ practice	Processing Power Program Comprehension Power Program
• Inadequate rate with comprehension	Guided Reading training	Processing Power Program
• Poor information processing	Guided Reading training	Processing Power Program Comprehension Power Program

As this chart suggests, many of I/CT's various fluency building techniques will influence a change in a number of oculo-motor characteristics as visual/functional, perceptual, and informational processing sub-skills are altered. Many of these techniques are also mutually reinforcing. As a consequence a school has a wide latitude in the number of options available in selecting and using these various fluency building techniques. The basis for selecting and using these techniques, however, is a subject for another discussion.

Goal:

Improved fluency, not
eye-movement training

At all levels of reading instruction, whether developmental or remedial in nature, tachistoscopic Guilded Reading training and computerized fluency building techniques can, and should, be employed to develop adequate levels of reading fluency. *These training techniques are the most expeditious means of developing efficiency and fluency in silent reading.* And with some students, these techniques are the only effective means of developing efficiency and effectiveness.

In connection with many instrument techniques and devices, one still hears reference to "widening span," "controlling eye movements," "training fixation patterns," and "tripling reading rates." These phrases represent misunderstanding of proper function of instrument techniques and the manner in which they influence oculo-motor behavior and contribute to reading improvement. This is not to suggest that instrument training techniques, tachistoscopic or those that present reading material in a timed and left-to-right manner, produce little improvement in eye-movement patterns; for it has been shown repeatedly that they do. Again, the primary contribution of instrument techniques lies in the control they exert and the training effect they have on the sub-skills employed by the reader. Improvements can be made in (1) binocular coordination and motility by guided and accelerated presentations, (2) visual discrimination and visual memory through flashed or timed exposures, (3) directional attack by left-to-right presentations, and (4) retention and comprehension through attention-compelling activities that develop more complete comprehension and competency in various study skills.

To conclude, eye-movements are neither the cause nor the effect of good or poor reading. The eyes do not dictate to the mind what it shall understand; neither does the mind dictate to the eyes where they shall look. Instead, there exists an interaction and interdependence between the oculo-motor activity and the central processes, each function indirectly influencing the other.

While undoubtedly there is still much to be learned through eye-movement photography, it is hoped that this review of the research findings to date will clarify the role of eye movements in reading, help establish realistic goals for reading instruction, and perhaps provide criteria for the selection of materials and techniques to be used in improving the visual/functional, perceptual, and information processing abilities of students.

References

1. Ballantine, Francis A., "Age Changes in Measures of Eye Movements in Silent Reading," Studies in the Psychology of Reading, pp. 67-111. Monographs in Education, No. 4. Ann Arbor: University of Michigan Press, 1951.

2. Carmichael, Leonard and Walter F. Dearborn, Reading and Visual Fatigue. Boston: Houghton Mifflin Company, 1947.

3. Gilbert, Luther C., "Effect on Silent Reading Reading of Attempting to Follow Oral Reading." Elementary School Journal, 40 (April 1940), 614-21.

4. Litterer, Oscar F., "An Experimental Analysis of Reading Performance," Journal of Experimental Education, 1 (1932), 28-37.

5. Morse, William C., "Comparisons of the Eye Movements of Fifth and Seventh Grade Pupils Reading Materials of Corresponding Difficulty," Studies in the Psychology of Reading Monographs in Education, No. 4, pp. 3-64. Ann Arbor: University of Michigan Press, 1951.

6. Seibert, Earl W., "Reading Reactions for Varied Types of Subject Matter," Journal of Experimental Education, 12 (1943), 37-44.

7. Taylor, S.E., The Dynamic Activity of Reading, Huntington, New York: EDL/McGraw-Hill, Inc., 1971.

8. Taylor, Sanford, Frackenpohl, Helen, and Pettee, James L., "A Report on Two Studies of the Validity of Eye-Movement Photography as a Measurement of Reading Performance," Reading in a Changing Society, International Reading Association Conference Proceedings, Volume 4, 1959. (Also reprinted as EDL Research & Information Bulletin No. 2.)

# # #

The PortaBraille - A Communication Device For The Blind

Wayne Thompson
Kentucky Department for the Blind
Frankfort, KY

The PortaBraille is a portable braille device for blind and deaf/blind individuals. It was developed by the Kentucky Department for the Blind, Technical Services Unit. An obvious need has existed for some time for a low cost (under $1,000), portable, refreshable braille device. These initial goals of low cost and portability have been realized in the PortaBraille.

The PortaBraille contains a twenty cell refreshable braille display which serves as a twenty character window into the 56K of memory available for text. A seven key braille keyboard allows the user to enter text directly as well as issue commands to invoke various modes and set operating parameters. Text may also be input to or output from the PortaBraille through the RS232 serial port or the Centronics compatible parallel port.

The RS232 serial port can be configured by user keyboard commands for full or half duplex, selectable baud rates, parity options, stop bits, data length, and handshaking options. The RS232 serial port uses the standard DB25 connector with either software (X-on, X-off) or hardware (DTR, DSR) handshaking. This port allows the PortaBraille to communicate bi-directionally with any other device containing an RS3232 port such as ink or braille printers, modems, speech devices, and computers.

The Centronics compatible parallel port can be configured by user keyboard command as an input or an output port. For example, configured as an input, the PortaBraille could be connected directly to the printer port of a personal computer like the IBM PC and display in braille any text directed to it. If the PortaBraille parallel port is configured as an output port, it could directly drive a printer, speech box, or other device having a standard Centronics compatible parallel input.

The seven key braille keyboard can generate the entire 128 ASCII character set including all control characters. Likewise, special keyboard commands allow the user to view any ASCII character on the braille display including control characters, upper case, and lower case characters. Grade two braille or any other braille code may be entered from the keyboard provided the text will always be read in braille. Obviously, if text is to be read by sighted persons then the computer braille code must be used. The PortaBraille automatically converts all communication between the braille keyboard, braille display, and Input/Output ports to the appropriate code either ASCII or computer braille.

The PortaBraille is housed in a rugged ABS plastic enclosure measuring approximately 8" x 6" x 2 1/2" and weighs about four pounds. The rechargeable battery pack and recharging circuit are built into the PortaBraille. The only external part is the AC line cord which connects to a 115 VAC (or optionally 230 VAC) power source. Connecting this line cord will fully recharge the batteries in eight hours. A full charge will operate the PortaBraille for at least ten hours with continuous braille display activity. When the braille display is not active, the PortaBraille automatically enters a power-down mode. Therefore, under typical usage a full charge would last for days or even weeks. The unit may also be operated directly from AC power (while also charging the batteries) by simply plugging in the line cord.

Many operating features are built into the PortaBraille's firmware and are instantly available to the user by simply entering the appropriate chord command to invoke the feature. Some of these include; moving the twenty-cell braille "window" forward or backward through the text; showing upper case and/or control characters; backspace; delete and insert text; find a text string within the buffer; append linefeeds to carriage returns; move cursor left and right within the braille window; transmit text (line, paragraph, or all); select one or both ports as output; self test; braille image of the screen of various popular computers such as the IBM PC, Apple, and Radio Shack Model 100; word mode which displays lines of braille text without breaking words; columnar mode which allows the braille display of columnar data by user selection of left and right column boundaries; speech mode for routing all braille windows to an external speech box; settable line length for transmitting text at preset line lengths. Many of these keyboard commands may also be invoked by a remote system through various escape sequences.

Space does not permit a fuller explanation of these features but detailed operating instructions can be found in the Kentucky PortaBraille Users Guide. Also available is the Construction Manual for the Kentucky PortaBraille. This document contains complete step-by-step instructions on how to build a PortaBraille. It includes parts lists, suggested parts vendors and manufacturers, schematics, drawings and photographs. It was designed so that any person with only moderate skills in electronic assembly could use this construction manual to order parts and build a working PortaBraille in about 10 hours. Total parts cost is approximately $800. Both the User's Guide and the Construction Manual are available to anyone for a nominal charge of five dollars to cover our cost of reproduction.

We are expecting PortaBrailles to become commercially available from one or more manufacturers in the near future. A kit of parts may also become available. To get the latest information on these possibilities, order manuals, or simply ask questions about the PortaBraille, please contact the Kentucky Department for the Blind, Technical Services Unit, 427 Versailles Road, Frankfort, Kentucky 40601, or phone (502) 564-4754.

We hope that the PortaBraille will contribute in some small way to our ongoing and ultimate objective of placing high technology at a low cost into the hands of those who can benefit from it the most.

# # #

Computer Applications In Deaf Education

Renee Trachtenberg
BOCES Program for the Hearing Impaired
North Merrick, NY

More powerful than an electronic workbook, the microcomputer has many important applications in the field of education of the deaf. These include computer assisted instruction, word processing, data base programs, spreadsheets, authoring systems and programming languages such as Basic and Logo. Taylor (1980) suggests a method for understanding and organizing the application of computers in education. He divides educational computer usage into three modes. In the first mode, the computer is utilized as a "tutor." To function as a tutor in a particular subject, the computer must be programmed by experts in programming and in that subject. According to Taylor (1980, p. 3) "the student is then tutored by the computer executing the program or programs. The computer presents some subject material, the student responds, the computer evaluates the response, and from the results of the evaluation, determines what to present next. At its best, the computer tutor keeps complete records on each student being tutored; it has at its disposal a wide range of subject detail it can present; and it has an extensive and flexible way to test and then lead the student through the material. With appropriately well-designed software, the computer tutor can easily and swiftly tailor its presentation to accommodate a wide range of student differences." The tutor mode is often referred to as CAI -- Computer Assisted Instruction. Its base may be a mainframe computer with many student terminals, or software booted on a microcomputer. According to Suppes (1980), the tutor mode can provide drill and practice, introduce new concepts and offer a dialogue or interactive program with students.

In the second mode, the computer is utilized as a "tool." To function as a tool, a particularly useful capability must be programmed into the classroom computer. (Taylor, 1980) A computer that has been programmed as a word processor may be used by the student as a tool. A computer that has been programmed to organize and retrieve materials, as is the case with a data base, may also be used by the student as a tool. The same is true with the computer as a calculator or spreadsheet.

In the third educational application, the computer functions as a "tutee." According to Taylor (1980, p. 4) to "use the computer as a 'tutee' is to tutor the computer; for that, the student or teacher doing the tutoring must learn to program, to talk to the computer in a language it understands. The benefits are several. First, because you can't teach what you don't understand, the human tutor will learn what he or she is trying to teach the computer. Second, by trying to realize broad teaching goals through software constructed from the narrow capabilities of computer logic, the human tutor of the computer will learn something both about how computers work and how his or her own thinking works. Third, because no expensive predesigned tutor software is necessary, no time is lost searching for such software and no money spent acquiring it." Luehrmann (1980, p. 133) states that "computing constitutes a new and fundamental intellectual resource." Luehrmann perceives as wasteful the use of this powerful resource as a mere delivery system for instruction, as in the case of CAI. He suggests that a student receive instruction in how he might use the resource himself. "What a loss of opportunity if the skill of computing were to be harnessed for the purpose of turning out masses of students who were unable to use computing!" (Luehrmann, 1980, p. 134).

How do these three modes of computer usage apply to the educational of deaf children? The use of the tutor mode -- or CAI -- with hearing impaired students is well documented in the literature. Rose and Waldron (1984) report the findings of a national survey of microcomputer use in programs for hearing-impaired children. Of the 342 programs surveyed, 82% responded, and 51% used microcomputers as an instructional aid. The survey found a total of 979 microcomputers being used in 115 programs serving hearing-impaired students. There was an average of 8 microcomputers per school. According to Rose and Waldron, drill and practice -- a typical example of computer assisted instruction -- was the primary use of the microcomputer by 80 of the 115 users. Tutorial usage -- described as the presentation of materials and questions to students -- was also a popular application. In the area of math computational skills, there is a wide variety of software that is appropriate for use with hearing-impaired students. Most software will keep track of students' scores and many have diagnostic tests that automatically place students at appropriate levels. In this subject area, it is also easy to integrate computer activities with classroom curriculum. Concept based programs -- such as "Juggle's Rainbow," "Gertrude's Secrets," and "Rocky's Boots" -- all from The Learning Company -- are wonderful ways to allow all children to discover opposites, attributes and Logic. It is difficult though to find appropriate CAI materials in the areas of reading and language for hearing impaired students. The need for appropriate instructional software for use with hearing-impaired students in the language areas was also noted by Rose and Waldron. Although there is some commercially available software developed specifically for hearing impaired students in the area of language arts -- Dormac's syntax program being one example -- most language arts material is inappropriate. The vocabulary is often unfamiliar to the prelingually deaf and must be pretaught before the software can be used. If a teacher is using a particular reading text, and other written language and spelling materials with her students, the addition of the vocabulary of unrelated computer software can be overwhelming for the student. Of course a teacher could select particular software and use it as the primary source of instruction.

Although properly classified in the "tutee" mode, programming languages can be used by teachers to create their own individualized CAI type software. A creative teacher can use the Basic and Logo programming languages to write programs that help children create poetry, use prepositions appropriately, develop sequencing skills, improve reading and enhance many other language related abilities. With a fundamental knowledge of these two programming languages, teachers can alter programs found in the computer literature to meet the specific needs of the deaf youngsters in their classes.

Another educational computer application that bridges the tutor and tutee modes is the authoring system. An authoring system allows classroom teachers to create CAI-type software to meet the particular needs of his or her students. Authoring systems have always been popular with teachers of the hearing impaired. Fleming (1983) discusses use of the Blocks Authoring System at the California School for the Deaf. According to Fleming, the Blocks system enables teachers without any programming experience to create and illustrate lessons that run on the computer. These lessons can be for any subject at any grade level. Although the Blocks system seems valuable, Pollard and

Shaw (1982) have found the actual process of transferring Blocks lessons from paper to disk to be quite time consuming and suggest the use of aides and volunteers to help with construction of lessons. Teachers at the Nassau BOCES Program for the Hearing Impaired have found EZ Pilot, an authoring language developed by Earl Keyser, to be an effective authoring system for use with hearing impaired students. Teachers may create lessons that reinforce exactly what is being taught in the classroom. Truly easy to learn, I have used EZ Pilot to develop individualized reading, spelling and math applications software for may students. EZ Pilot may be used with the Koala Pad touch tablet -- allowing teachers and/or students to draw accompanying graphics freehand as they would with a ditto. When an authoring system is as easy to use as a ditto, teachers will really use it.

Fleming (1983), Moore (1983) and Smaldino et. al. (1983), all refer to the use of the tutor -- or CAI -- mode of microcomputer usage. These educators appear to have overlooked the function of the computer as a tool with hearing impaired students. How can the tool mode of computer usage be adapted to the hearing impaired student? When programmed as a word processor, the computer is a wonderful and powerful learning tool for hearing impaired students. Unlike programming languages -- which we will discuss later within the tutee mode -- use of the word processor requires a minimum of teacher training. (The tutor -- or CAI -- mode requires virtually no computer expertise on the part of the teacher -- beyond knowing how to insert software and turn on the computer.) The application of word processing to the development of the written language skills of deaf children is only limited by a teacher's imagination. It is a powerful motivation tool.

Word processing is also a lifelong marketable skill. Language development and word processing can go hand in hand. Rather than using "dittos" for teacher-made language exercises, a teacher may type these exercises using a word processor and save them to a disk. The disk may be loaded in class; each student go through the exercises and print out a copy. Errors may be discussed, and then corrected on the computer. Perfect copies may then be printed. Some activities easily adapted to the word processor are sequencing skills, grammatical exercises, spelling, vocabulary development, alphabetizing and most importantly -- creative writing. Together with a graphics tool -- such as a Koala Pad touch tablet or Printers Workshop -- students can use the word processor to write a class newspaper or create story books for younger students. Social studies and science reports may be written on the word processor. Most importantly, computer activities can truly be integrated with the rest of your curriculum. You can easily use science vocabulary, review spelling words and practice specific syntactic structures. A spelling check program is available with most word processing programs if desired by the teacher. A teacher will also find a word processor invaluable for her/his own paper work. The word processor will one day make the typewriter obsolete. Incidentally, I prepare my plan book weekly on the word processor.

A data base program is also a wonderful computer tool that can be used in the education of deaf children. Caron (1984) and Hunter (1984) both suggest use of a data base program as part of a science or social studies curriculum. PFS File is a data base program easily used by students -- hearing or hearing impaired -- to help with research projects. The PFS data base allows you to create "fields" or "categories" that will accept information. If the form you create relates to countries, some of the fields might be "name of country," "capital city," "goods produced," etc. The program then allows you to perform certain functions upon this information. For example, you may search and find all of the countries that produce wheat. Such a program can be used to develop tailor-made research tools for hearing impaired children at their particular language and conceptual level. Of course, a teacher may use a data base system to keep class records or lesson plans. As an educational tool, the data base allows the computer to become an integral part of the curriculum. The student also has the added bonus of learning to use a data base -- an important tool in the business world.

Another tool application of the microcomputer in education is the spreadsheet. It can be used in high school math class to illustrate how business predictions can be made. What if a company sells 100 more cars next year than this year? A spreadsheet can instantly give you the profit expected should this occur. Spreadsheets are commonly used in the business world, and hearing impaired students should have an opportunity to become familiar with them while still in school. A spreadsheet can also be used by the teacher to keep records of student grades. Grades may be instantly averaged for a series of tests.

When a student -- hearing-impaired or not -- learns to speak the language of the computer, he or she is functioning within the "tutee" mode. The student is actually teaching the computer. The computer becomes an intellectual environment for the student (Luehrmann, 1980). How can the tutee mode be applied to the education of hearing-impaired children? Hearing-impaired students can learn to write computer programs, thereby growing intellectually. In addition, Moore (1983) recognizes computer programming as an excellent occupation for hearing-impaired people. Deaf students may learn to write programs in Logo, Basic or other programming languages.

What is Logo? Logo is a computer language that was developed by Seymour Papert at M.I.T. It uses simple commands that allow the child to easily draw pictures on the computer screen. The child may draw pictures in the immediate mode and see his or her work "immediately," or the child may use the edit mode to write and save programs that will draw pictures for him or her when these programs are called by their names. The graphics cursor, which is triangular in shape, is called a "turtle" -- hence the name "turtle graphics."

Why is Log appropriate for hearing impaired children? Hearing impaired children, particularly the prelingually deaf, have great difficulty acquiring language. In fact, the development of speech and language is the most important aspect of the hearing impaired child's education. Although a week area for deaf children, language must often be used to convey concepts in other curriculum areas. Logo can encourage language growth, and developing procedures and solving problems with Logo does not require a level of linguistic competence which a deaf or hearing impaired child might not have. Logo can provide an opportunity to use a child's firm knowledge of space and his or her body to explore math (turtle geometry) and physics (Papert, 1980). The child need not be able to comprehend or produce complex syntactic structures in order to use Logo commands and develop procedures. Through the use of these commands and procedures, he can have numerous opportunities for language development. In my classroom, I have found Logo to be an exciting way to help hearing-impaired children acquire concepts of directionality and sequencing, explore geometry, learn to follow and give spoken and written decisions, improve language ability, develop different approaches to problem solving and learn to work together.

Several articles concerning the use of Logo with hearing impaired children can be found in the literature. Grand and Semmes (1983) used Logo with five year old twins, one profoundly deaf and the other with normal hearing. They presumed that Logo could "promote both proficient language (e.g., vocabulary, syntax, and recursive property) (p. 565)" could help young children develop linguistic awareness. Grant and Semmes recognize a relationship between Logo's process of making a square and the language principle of conjoining. "The finished square is composed of four equal commands, just as a compound sentence, subject or predicate is composed of as many equal components as desired." (Grant and Semmes, 1983, p. 569.) These authors saw a great deal of verbal interaction between their students during eight half hour sessions. The growth and enjoyment experienced by the children convinced the authors that the use of Logo with preschool children, both hearing and hearing impaired, is appropriate (Grant and Semmes, 1983).

Patrick Stone (1983) of the Tucker-Maxon Oral School used Logo with a group of 14 profoundly hearing impaired children, ages 8-14. Stone states that his students developed skills in problem definition, programming, editing, and debugging through the use of Logo. In addition to becoming computer programmers in the true sense by controlling the computer rather than being controlled by it, Stone's students' experiences with Logo fostered "peer interaction and provided opportunities for aesthetic expression." (Stone, 1983, p. 648)

What other computer languages can hearing impaired students learn to speak? Basic is a common computer language taught in most schools -- for hearing as well as hearing impaired students. In their study, Rose and Waldron (1984) found that approximately 85% of hearing impaired schools using computers had the Basic language available. Incidentally, Logo and Pilot languages were found in only 10% of the schools. The authoring language EZ Pilot is a good first computer language for students to learn. Seventh graders, for example, might use the EZ Pilot language to write CAI software for third or fourth graders. According to Papert (1980), the best way to learn something is to teach it. By constructing a reading lesson, older students will learn a great deal about the material they are using -- including syntax, vocabulary and spelling.

Summary

In conclusion, the microcomputer can have three different modes -- or functions -- in the education of hearing impaired students. The microcomputer can be a tutor, tool or tutee. (Taylor, 1980) CAI may be best for computation; the word processor for developing language; Logo for problem solving; the data base for research; and so on. The tutor and tool modes require a minimum of teacher training, as does the EZ Pilot authoring language. Computer activities can become an integral part of the hearing impaired curriculum. Use of the microcomputer in the classroom should not be thought of as a separate educational activity, but rather a technological instrument that expands a student's intellectual environment.

References

Caron, W. (1984, November/December). Exploring the animal kingdom. Teaching and Computing, 16-19.

Dompier, S. (1983). Micro Illustrator Disk. Koala Technologies Corp. New York: Island Graphics Corp.

Fleming, R. (1983, September). Recent changes in CAI at CSDF. American Annuals of the Deaf, 707-709.

Grant, J. & Semmes, P. (1983, September). A rationale for Logo for hearing impaired preschoolers. American Annuals of the Deaf, 564-569.

Hunter, B. (1984). My students use computers. Reston, Va.: Reston Publishing.

Keyser, E. (1983). E-Z Pilot. White Bear Lake, Mn.: Teck Assoc.

Luehrmann, A. (1980). Should the computer teach the student, or Vice-Versa? In R. Taylor (Ed.), The computer in the school: Tutor, tool, tutee. (pp. 129-135). New York: Teachers College Press.

Mack, R., Page, J., and Roberts, D. (1983). PFS: File. Mountain View, CA: Software Publishing Corp.

Moore, M. (1983, September). The expansion of analytical thinking of the science student through interaction with the TRS-80. American Annuals of the Deaf, 714-716.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books.

Pollard, G. & Schaw, C.C. (1982, September). Microcomputer Reading Comprehension Improvement Program for the Deaf. American Annuals of the Deaf, 483-486.

Rose, S., and Waldron, M. (1984, June). Microcomputer use in programs for hearing-impaired children: A national survey. American Annuals of the Deaf, 338-342.

Smaldino, S., Schloss, P., Goldsmith, L., and Selinger, J. (1983, September). Analysis of the relative instructional efficiency of microcomputer-based instruction and teacher-directed instruction for hearing-impaired and normal-hearing youth. American Annuals of the Deaf, 642-647.

Stone, P.S. (1983, September). Logo: A powerful learning environment for hearing impaired children. American Annuals of the Deaf, 648-652.

Suppes, P. (1980). The teacher and computer assisted instruction. In R. Taylor (Ed.), The computer in the school: Tutor, tool, tutee. (pp. 231-235). New York: Teachers College Press.

Taylor, R. (Ed.) (1980). The computer in the school: Tutor, tool, tutee. New York: Teachers College Press.

# # #

The Integration of Logic Software Into The Curriculum Through Activities Away From The Computer

Linda Ware
Ysleta I.S.D.
El Paso, TX

The focus of this presentation will be to demonstrate the successful integration of the graphic tasks from Gertrude's Secret's, Gertrude's Puzzles, Moptown Parade, and Moptown Hotel into the curriculum for LD, ED, or self-contained Special Education students. This software is generally classified as logic/problem solving, but specifically it promotes the student's ability to:

1. discriminate between color and shape
2. order and classify by pattern and by sequence
3. recognize similarities and differences
4. use deductive reasoning, as well as creative thinking
5. enhance the development of problem solving strategies

The four software packages rely on shapes, colors, and the Moptown critters, presented with a variety of graphics, including: Trains, Arrays, Networks, Clubhouse, and Moptown Map. In each, the student uses "same and differences" classification schemes to successfully solve the problems using these graphics.

Because the computer provides colorful graphics, immediate feedback, and a non-threatening learning situation, most students will consider this "game-software." Unfortunately, they will be reluctant to incorporate their newly acquired thinking skills in other areas of learning away from the computer. However, the teacher can, using worksheets similar to the graphic arrangements presented in this software, reinforce these same concepts across several content areas.

Once the students have had sufficient time to work with the software, they can begin to incorporate their newly acquired deductive reasoning skills in guided activities away from the computer. Using the teacher-made worksheets the students can recreate trains, arrays, and networks similar to those found in the software. In spite of their recent success with the software, there are many students who may have difficulty doing this assignment on their own. And just as they pondered and thought to get the right answer when working on the computer, they again ponder and question, as they complete the worksheets. With ample practice at this level the students can begin to transfer their skills to other content areas.

Depending on the student's individual needs and abilities, the worksheets, can be used to improve letter recognition; to differentiate between nonsense words consisting of letters frequently reversed by LD students; to reinforce the properties of numbers and place value -- and the list goes on! Regardless of the subject matter, students must recognize patterns, similarities and differences. Through these graphics, their learning is enhanced.

These activities transcend the usually mundane, drill and practice work special education students often require; as a result they are more willing to approach the learning tasks. In fact, my students were so motivated by these worksheets, they soon began to challenge each other with graphics detailing the similarities and differences of their favorite rock groups, songs and movies. Their lively arguments in defense of their graphics was amusing; but more important, it was obvious their thinking and reasoning skills had improved, and they had become more confident about their ideas and thoughts.

# # #